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NEW DIRECTIONS FOR NUCLEAR R.D. & D., POST-INFCE

HEARINGS
BEFORE THE
SUBCOMMITTEE ON
ENERGY RESEARCH AND PRODUCTION
OF THE
COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
NINETY-SIXTH CONGRESS
SECOND SESSION

JUNE 4, 5, 1980

[No. 152]

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Committee on Science and Technology

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NEW DIRECTIONS FOR NUCLEAR R.D. & D., POST-INFCE

WEDNESDAY, JUNE 4, 1980

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION,
Washington, D.C.

The subcommittee met, pursuant to notice, at 2:13 p.m., in room 2318, Rayburn House Office Building, Hon. Mike McCormack (chairman of the subcommittee) presiding.

Mr. McCORMACK. The meeting will come to order, please.

Ladies and gentlemen, as is not uncommon, we are forced to hold our committee meetings during the time the House is in session. As a result, we will not only be short of members today, but we will also be called away on occasion for votes. I am sure you understand, and I trust you will all accommodate yourselves to that problem.

Today the Subcommittee on Energy Research and Production begins hearings on the International Nuclear Fuel Cycle Evaluation, known as INFCE. As many of you know, INFCE was a technical evaluation of all aspects of alternative nuclear fuel cycles to identify nonproliferation questions and advantages and disadvantages and methods to improve safeguards for existing technologies.

The central theme of the hearing is to evaluate the implications of INFCE on the direction and priorities of the Nation's nuclear research, development and demonstration programs. In order to accomplish this, we will hear testimony covering many of the broad aspects of INFCE. This will include an historical understanding of the genesis and the purposes of INFCE, and a detailed look at the results of INFCE and how they support and diverge from current U.S. policies.

The effects of these policies will be explored, as well as the perceptions that foreign nations have of the United States, and how this has affected the development of nuclear power in other countries. We will also explore the effect of our policies on foreign nuclear R.D. & D. programs, and in particular, those programs which the United States is actively engaged in and for which, in some cases, we have joint undertakings with foreign nations.

I am aware that reassessments of U.S. policy are underway, as well as reassessments of the policies of foreign nations and how they will interact with the United States in the future. While proliferation concerns are of extreme importance, they cannot form the sole basis for decisions on policies which may have significant economic and societal impacts upon the United States and the world. Therefore, it is prudent and timely that we consider the directions that nuclear R.D. & D. programs should take.

Nearly 40 years after the first demonstration of the feasibility of nuclear weapons, international concern about the possible proliferation of nuclear weapons is more urgent and widespread than ever, more urgent because the prerequisite technology and materials are no longer the closely guarded possessions of only one or even five States; more widespread because the inevitable dissemination of technology and materials has caused, on the one hand, supplier nations to fear the proliferation potential of their actions, and on the other hand, a growth of nuclear suspicions between nations where dangerous political tensions already exist.

Because of serious concern over increased proliferation and perhaps because of a desire on the part of some to stop the further development of nuclear power on ideological grounds, President Carter in 1977 placed severe restrictions, as far as the administration was concerned, on the development of advanced nuclear systems in this country and the export of nuclear technology and materials.

These policies, however, have not reduced the international threat of proliferation. In the 3 years since President Carter announced his policy of no reprocessing of spent fuel and no breeder reactor development, the nuclear power capability of the United States and its influence on foreign countries to prevent proliferation has steadily decreased.

The INFCE, which was initiated by the administration to delay further decisions on nuclear power development, has been completed and the 66 participating nations have rejected the U.S. policy. Instead of using U.S. technology and resources, foreign nations are aggressively developing their own reprocessing, enrichment and breeder capabilities, over which the United States will have little influence.

The United States must now move forward with realistic domestic and international nuclear policies and programs if we are going to meet our own domestic needs and, at the same time, limit the threat of proliferation.

The issue before us is complex and will occupy the governments of many nations for some time to come. I do not expect to resolve all of these issues through this hearing. However, because of the active participation of many of our witnesses in the INFCE process, their involvement at all levels within government and industry as well as other associations, and their wide range of views, I anticipate significant clarification of many of the issues before us.

These are the important issues the subcommittee will be looking at as we begin these hearings.

When Congressman Wydler, our ranking minority member arrives, I will provide him with an opportunity to make an opening statement.

Until that time, I shall proceed, and I would like to ask Hon. Thomas Corcoran, Member of Congress from the State of Illinois, to come to the table. Mr. Corcoran has shown an active interest and a leadership role in establishing nuclear power policies, and particularly the effect of the administration's nonproliferation policies and how they have impacted the development of nuclear power in the United States.

As a delegate to the Republican National Convention, Mr. Corcoran has testified on this matter before the Republican National Convention Platform Committee.

We are honored to have you join us this afternoon. We have a copy of your testimony before us, and you may proceed as you wish.

STATEMENT OF HON. TOM CORCORAN, CONGRESSMAN FROM THE STATE OF ILLINOIS

Mr. CORCORAN. Thank you very much, Mr. Chairman.

I am very happy to have the opportunity to testify before your subcommittee this afternoon on the implications for the United States relative to our post-INFCE policy, and I want to commend you and your committee for holding these hearings and the leadership over the years that you have shown on these matters.

I would ask that my entire statement be entered into the record, including my five Congressional Record statements made in February, March, and May of this year, as well as the joint letter which five of my colleagues joined me in sending to the Nuclear Regulatory Commission on June 2.

Mr. McCORMACK. Without objection, this material will be included in the record.

Mr. CORCORAN. Thank you very much.

Mr. Chairman, the International Nuclear Fuel Cycle Evaluation was instigated, as you correctly pointed out, a few years ago as a result of the encouragement of President Carter. INFCE concluded its 2½ year effort in February of this year. The United States assumed the responsibility of paying 38 percent of the direct costs of this 66-nation undertaking. These direct costs represent direct assessments to administratively support INFCE and do not include the additional costs borne by the U.S. Government in support of the U.S. delegation which attended various INFCE meetings, all but one of which were in Vienna.

I think the appropriate question at this point is: What did we receive for this expenditure? Essentially, in my opinion, we received confirmation that the United States is increasingly in a position of standing alone in terms of nuclear energy policy. INFCE supports the rapid development of advanced nuclear technology.

In my mind, INFCE was a success for two reasons. First, this international body concluded that we must move ahead with advanced nuclear technology. For instance, on the issue of reprocessing, the report stated that reprocessing "in itself is important because it is an essential preliminary to many of the possible fuel cycles."

Second, in some respects, INFCE was a success because it provided a convenient excuse for the Carter administration to delay moving ahead with the same nuclear technology our European and Japanese allies are so vigorously pursuing. While I probably would not have objected in 1977 to establishing this international body, I do object now to delaying any longer the implementation of a policy favorable to reprocessing in this country.

I support reprocessing for three reasons. First, just as all the other countries in the world that use nuclear power commercially have opted for reprocessing in order to break their dependence on OPEC oil, I believe that the United States should do likewise.

Second, reprocessing provides a good way to get more energy. Out of every 1,000 pounds of spent fuel, reprocessing can retrieve approximately 960 pounds of fuel that can be used again in our nuclear powerplants.

Third, reprocessing is the key to a sensible, safe nuclear waste management program. After reprocessing out 960 pounds of new energy, we would be left with only 40 pounds of nuclear waste to dispose of. Like every other country in the world in this business, we could then vitrify or glassify this waste for safe, permanent disposal in appropriate underground geological formations, such as salt mines.

I viewed this approach firsthand last January when I inspected a number of nuclear facilities in Great Britain, France, and Germany.

Mr. Chairman, I believe that the United States has two options with respect to post-INFCE nuclear policy. First, it can continue its present posture of standing alone in terms of international nuclear energy policy. The unfortunate situation in which we find the United States at the conclusion of this 2½-year effort is that we see yet another aspect of our failed foreign policy drifting without any true focus on productive conclusions.

U.S. nuclear policy is unquestionably driving our European allies to the Soviet Union for enriched uranium. In my opinion, this would lead to a continuation of an almost total lack of U.S. credibility abroad. It would mean that we would continue to settle for an almost total lack of influence on systems and technologies to be used in the international implementation of nuclear fuel cycles.

It would further alienate our European and Japanese allies by insisting that they comply with policies contrary to their own national energy security interests.

Finally, it would send a message to developing nations that the United States has charted a path as a major and expanding consumer of fuel supplies vital to their energy security interests; in other words, that we will be as dependent on available uranium supplies as we are currently dependent on available petroleum supplies.

I would inject into my formal statement a comment that was passed along to me by one of the European officials, who pointed out when I visited Europe in January that one of the absurdities of our present policy, where we are curtailing the advancement of nuclear technology and its commerical application here in the United States, is that this policy hurts the underdeveloped countries which would like to be able to use oil for their less advanced industrial development at this point. We are using the oil which we could otherwise divert to their development because of our failure to break our dependence on oil and move to other, more sophisticated technologies, such as the nuclear technologies to which I have referred.

Second, the United States can modify its policy in view of INFCE and other developments, such as British, French, and Japanese commitments to build major conventional fuel reprocessing facilities for operation by 1990. This policy would cut losses already incurred by American taxpayers and electric rate payers. It would rekindle hope that the United States at some time may be in the position to honor the long-standing commitment to be a reliable supplier of fuel, particularly to developing nations.

Finally, such a policy would assure that the United States would have an active leadership role in defining the international approach to the nuclear fuel cycle. Obviously, I favor this second policy approach.

My recommendation, Mr. Chairman, would be that the Congress should be the nuclear policymaking body in this country. The President proposes, but the Congress disposes. In the case of the current administration, we obviously cannot look to the President to propose the kind of nuclear policy which I believe we must pursue. Particularly in the face of this administration's intransigence, I believe that the Congress must play a major role in nuclear policy.

There exists one specific action which represents a logical next step in our nuclear policy. I refer to the so-called GESMO rulemaking proceedings over at the Nuclear Regulatory Commission, which I would recommend be resumed. The proceedings relating to GESMO, the generic environmental statement on mixed oxide fuel, were terminated by an NRC order on December 23, 1977. This termination order was clearly in response to an October 4, 1977 letter to the NRC from Stuart E. Eizenstat, Assistant to President Carter for Domestic Affairs and Policy.

The NRC had written to the President on May 5, 1977, asking for his views on GESMO. When NRC terminated GESMO, the Commission noted that it intended "to reexamine (the order) after the completion of the ongoing alternative fuel cycle studies, now expected to take about 2 years." Of course, they were referring to INFCE, as well as to the NASAP study the Department of Energy has taken at a cost of $24 million, which has recently been completed.

So I think it is clearly incumbent now for the NRC to reconsider its December 23, 1977 termination of the GESMO proceeding.

Even though INFCE concluded in February, NRC did not write to the administration, this time writing directly to Mr. Eizenstat, until, May 2. Interestingly, this letter was written only 2 days after the House Interior Committee failed by a 20–20 tie vote to direct the NRC to resume the GESMO proceedings. This vote occurred on April 30, with respect to H.R. 6628, the fiscal year 1981 NRC authorization bill.

I offered a different version of that amendment on May 30 in the Commerce Committee's Energy and Power Subcommittee. My amendment failed on a vote of 10–11. The full Commerce Committee, I can assure you, will get an opportunity to consider that amendment when we take up the the NRC authorization bill later this week or perhaps next week.

On another front, just the day before yesterday, I was joined by five colleagues in sending a joint letter to the NRC encouraging the Commission to resume the GESMO proceedings. I am proud and grateful to have as two cosigners of that letter the chairman and ranking minority member of this subcommittee.

In response to this June 2 letter, I fully expect NRC to write back to us saying that the Commission wrote to Mr. Eizenstat on May 2 seeking the administration views, and that the NRC will be happy to let us know what the administration's response is.

Furthermore, I fully expect Mr. Eizenstat's reply to NRC's May 2 letter to say that the administration is studying the results of INFCE, and that it would be inappropriate for NRC, supposedly an independent regulatory agency, to proceed with GESMO until the administration has completed its study of the INFCE report, that is, if Mr. Eizenstat chooses to answer at all.

In any event, I have been doing all I can to follow through with my recommendation that the GESMO proceedings be resumed, and I shall continue that course.

While the Science and Technology Committee does not exercise jurisdiction over the NRC, I believe that there is an important role for this subcommittee and its parent committee to play in resuming the GESMO proceedings. I would encourage respectfully that the committee pursue the following five actions:

1. Direct the Department of Energy to review the status of issues outstanding at the time of the 1977 termination of GESMO and proceed to document developments in both civilian and defense-related programs which have advanced the definition of these issues or have introduced new technologies for consideration, an activity for the balance of fiscal year 1980.

2. Direct DOE to review numerous research and development programs to verify the orientation which would supply a near-term resumption for GESMO proceedings, an activity for the balance of fiscal year 1980.

3. Direct DOE to begin discussions with NRC staff regarding recommendations for resuming GESMO proceedings, an actvity for the balance of fiscal year 1980.

With respect to the coming fiscal year, I would suggest two things: first, that you direct DOE to restructure its fuel cycle research and development programs to be consistent with any possible GESMO or post-GESMO needs, such as techniques for safeguards and physical security, techniques for transuranic waste transfer and disposal, and applications of high-level waste solidification techniques to online plant output requirements, an activity to be initiated in fiscal year 1981.

And finally, in that respect, direct DOE to establish any research and development programs that may be required to supply meaningful and reasonable evolution of regulatory standards for the back end of the fuel cycle, an activity to be initiated in fiscal year 1981.

And so, Mr. Chairman, in conclusion, I would hope that you and the rest of our colleagues in the Congress would join me in asking this administration whether or not it is prepared to take the steps necessary to reconstruct nuclear energy policy in a manner consonant with the needs of an energy-dependent world precariously linked with Persian Gulf resources, when the Carter administration now talks about military steps we may have to take to defend the oil fields for the benefit of the free world.

As a member of the Energy and Power Subcommittee, it is unpleasant enough to have to consider and vote on issues such as gasoline rationing, building temperature controls, and oil import fees. As a Member of Congress, I am even less enthusiastic about the possibility of being called on to vote on sending American military forces to the Persian Gulf.

Nuclear power is not the only solution to our need to reduce our dependence on the OPEC oil cartel. But it is a very important part of the total energy mix, and the Congress simply must look to nuclear energy as one of the best opportunities to reduce our dependence on foreign oil.

I hope my statement here today, as well as the actions I am pursuing through the Energy and Power Subcommittee, will be useful in promoting the safe use of nuclear power in this country.

Mr. Chairman, that concludes my prepared statement, and I would be happy to respond to any questions or comments the subcommittee may wish to pursue.

[The prepared statement of Mr. Corcoran plus five Congressional Record statements made in February, March, and May of this year, as well as the joint letter sent to the NRC follow:]

STATEMENT BY HON. TOM CORCORAN OF ILLINOIS

Mr. Chairman and members of the subcommittee, I commend you for your leadership in holding hearings on U.S. Post-INFCE policy, and I appreciate the opportunity to testify here today. Mr. Chairman, I ask that my entire statement be entered into the record, including my five Congressional Record statements made in February, March, and May of this year, and the joint letter which five of my colleagues joined me in sending to the Nuclear Regulatory Commission on June 2. All of this material is relevant to the hearing today.

OBSERVATIONS

Mr. Chairman, the International Nuclear Fuel Cycle Evaluation was instigated in 1977 as a result of the encouragement of President Carter. INFCE concluded its 2½-year effort in February of this year. The United States assumed the responsibility of paying 38 percent of the direct costs of this 66-nation undertaking. These direct costs represent direct assessments to administratively support INFCE and do not include the additional costs borne by the U.S. Government in support of the U.S. delegation which attended various INFCE meetings, all but one of which were in Vienna.

What did we receive for this expenditure? Essentially, in my opinion, we received confirmation that the United States is increasingly in a position of standing alone in terms of nuclear energy policy. INFCE supports the rapid development of advanced nuclear technology. In my mind, INFCE was a success for two reasons. First this international body concluded that we must move ahead with advanced nuclear technology. For instance, on the issue of reprocessing, the report stated that reprocessing "... in itself is important because it is an essential preliminary to many of the possible fuel cycles ..." Second, INFCE was a success because it provided a convenient excuse for the Carter Administration to delay moving ahead with the same nuclear technology our European and Japanese allies are so vigorously pursuing. While I probably would not have objected in 1977 to establishing this international body, I do object now to delaying any longer the implementation of a policy favorable to reprocessing in this country.

I support reprocessing for three reasons. First, just as all the other countries in the world that use nuclear power commercially have opted for reprocessing in order to break their dependence on OPEC oil, I believe that the U.S. should do likewise. Second, reprocessing provides a good way to get more energy. Out of every 1,000 pounds of spent fuel, reprocessing can retrieve approximately 960 pounds of fuel that can be used again in our nuclear power plants. Third, reprocessing is the key to a sensible, safe nuclear waste management program. After reprocessing out 960 pounds of new energy, we would be left with only 40 pounds of nuclear waste to dispose of. Like every other country in the world in this business, we could then vitrify or glassify this waste for safe, permanent disposal in appropriate underground geological formations, such as salt mines. I viewed this approach firsthand last January when I inspected a number of nuclear facilities in Great Britain, France, and Germany.

Mr. Chairman, I believe that the U.S. has two options with respect to post-INFCE nuclear policy. First, it can continue its present posture of standing alone in terms of international nuclear energy policy. The unfortunate situation in which we find the United States at the conclusion of this 2½ year effort is that we see yet another aspect of our failed foreign policy drifting without any true focus on productive conclusions. U.S. nuclear policy is unquestionably driving our European allies to the Soviet Union for enriched uranium. In my opinion, this would lead to a continuation of an almost total lack of U.S. credibility abroad. It would mean that we would continue to settle for an almost total lack of influence on sysems and technologies to be used in the international implementation of nuclear fuel cycles. It would further alienate our European and Japanese allies by insisting that they comply with policies contrary to their own national energy security interests. Finally, it would send a message to developing nations that the U.S. has charted a path as a major and expanding consumer of fuel supplies vital to their energy security interests; in other words, that we will be as dependent on available uranium supplies as we are currently dependent on available petroleum supplies.

Second, the United States can modify its policy in view of INFCE and other developments such as British, French, and Japanese commitments to build major conventional fuel reprocessing facilities for operation by 1990. This policy would cut losses already incurred by American taxpayers and electric rate payers. It would rekindle hope that the U.S. at some time may be in a position to honor the long-standing commitment to be reliable supplier of fuel, particularly to developing nations. Finally, such a policy would assure that the U.S. would have an active leadership role in defining the international approach to the nuclear fuel cycle. Obviously, I favor this second policy approach.

RECOMMENDATIONS

Mr. Chairman, I believe that the Congress should be the nuclear policymaking body in this country. The President proposes, but the Congress disposes. In the case of the current Administration, we obviously cannot look to the President to propose the kind of nuclear policy which I believe we must pursue. Particularly in the face of this Administration's intransigence, I believe that the Congress must play a major role in nuclear policy.

There exists one specific action which represents a logical next step in our nuclear policy. I refer to the so-called GESMO proceedings, which I recommend be resumed. The proceedings relating to GESMO (Generic Environmental Statement on Mixed Oxide Fuel) were terminated by an NRC order on December 23, 1977. This termination order was clearly in response to an October 4, 1977 letter to the NRC from Stuart E. Eizenstat, Assistant to President Carter for Domestic Affairs and Policy. The NRC had written to the President on May 5, 1977, asking for his views on GESMO. When NRC terminated GESMO, the Commission noted that it intended ". . . to re-examined (the order) after the completion of the ongoing alternative fuel cycle studies, now expected to take about two years." Now that INFCE has concluded, it is clearly incumbent on NRC to reconsider its December 23, 1977 termination of the GESMO proceedings.

Even though INFCE concluded in February, NRC did not write to the Administration (this time writing directly to Mr. Eizenstat) until May 2. Interestingly, this letter was written only two days after the House Interior Committee failed by only a 20–20 tie vote to direct the NRC to resume the GESMO proceedings. This vote occurred on April 30 with respect to H.R. 6628, the fiscal year 1981 NRC authorization bill. I offered a different version of that amendment on May 30 in the Commerce Committee's Energy and Power Subcommittee. My amendment failed on a vote of 10–11. The full Commerce Committee will consider the NRC bill soon, and I plan to offer my amendment again.

On another front, just the day before yesterday, I was joined by five colleagues in sending a joint letter to the NRC encouraging the Commission to resume the GESMO proceedings. I am proud and grateful to have as two co-signers of that letter the Chairman and ranking minority member of this subcommittee. In response to this June 2 letter, I fully expect NRC to write back to us saying that the Commission wrote to Mr. Eizenstat on May 2 seeking the Administration views, and that the NRC will be happy to let us know what the Administration's response is. Furthermore, I fully expect Mr. Eizenstat's reply to NRC's May 2 letter to say that the Administration is "studying" the results of INFCE, and that it would be inappropriate for NRC (supposedly an independent regulatory agency) to proceed with GESMO until the Administration has completed its "study" of the INFCE report. That is, if Mr. Eizenstat chooses to answer at all. In any event, I have been doing all I can to follow through with my recommendation that the GESMO proceedings be resumed, and I shall continue that course.

While the Science and Technology Committee does not exercise jurisdiction over the NRC, I believe that there is an important role for this subcommittee and its parent committee to play in resuming the GESMO proceedings.

1. Direct the Department of Energy to review the status of issues outstanding at the time of the 1977 termination of GESMO and proceed to document developments in both civilian and defense-related programs which have advanced the definition of these issues or have introduced new technologies for consideration—an activity for the balance of fiscal year 1980.

2. Direct DOE to review numerous research and development programs to verify the orientation which would supply a near-term resumption for GESMO proceedings—an activity for the balance of fiscal year 1980.

10. I encourage the committee to pursue the following five actions:

11. Direct DOE to restructure its fuel cycle research and development programs to be consistent with any possible GESMO or post-GESMO needs, such as techniques for safeguards and physical security, techniques for transuranic waste transfer and disposal, and applications of high-level waste solidification techniques to on-line plant output requirements—an activity to be initiated in fiscal year 1981.

12. Direct DOE to establish any research and development programs that may be required to supply meaningful and reasonable evolution of regulatory standards for the back end of the fuel cycle—an activity to be initiated in fiscal year 1981.

CONCLUSION

Mr. Chairman, I would hope that you and the rest of our colleagues in the Congress would join me in asking this Administration whether or not it is prepared to take the steps necessary to reconstruct nuclear energy policy in a manner consonant with the needs of an energy-dependent work precariously linked with Persian Gulf resources when the Carter Administration now talks about military steps we may have to take to defend the oil fields for the benefit of the free world. As a member of the Energy and Power Subcommittee, it is unpleasant enough to have to consider and vote on issues such as gasoline rationing, building temperature controls, and oil import fees. As a Member of Congress, I am even less enthusiastic about the possibility of being called on to vote on sending American military forces to the Persian Gulf. Nuclear power is not the only solution to our need to reduce our dependence on the OPEC oil cartel. But it is a very important part of the total energy mix, and the Congress simply must look to nuclear energy as one of the best opportunities to reduce our dependence on foreign oil.

I hope my statement here today, as well as the actions I am pursuing through the Energy and Power Subcommittee, will be useful in promoting the safe use of nuclear power in this country.

Mr. Chairman, that concludes my prepared statement, and I would be happy to respond to any questions or comments the Subcommittee may wish to pursue.

House of Representatives

WEDNESDAY, FEBRUARY 20, 1980

EUROPEAN NUCLEAR WASTE MANAGEMENT

The SPEAKER pro tempore. Under a previous order of the House, the gentleman from Illinois (Mr. CORCORAN) is recognized for 30 minutes.

Mr. CORCORAN. Mr. Speaker, as I indicated in my remarks to the House of Representatives on December 20, 1979, the last day of the first session of this Congress, I used part of the time between sessions to inspect a number of nuclear facilities in Great Britain, France, and Germany. My primary purpose was to look at their progress in handling the nuclear wastes which are developed in the nuclear fuel cycle. In the course of the 3-week tour, our delegation also had the opportunity to observe all other major aspects of European commercial nuclear programs as well.

Before discussing the nuclear programs and the specific facilities in each of the countries we inspected, I would like to assert my principal conclusion of the tour—the key to nuclear waste management is reprocessing spent nuclear fuel. All of these countries are far ahead of the United States in managing nuclear wastes. All of them have opted for reprocessing despite our decision to the contrary, announced by President Carter on April 7, 1977, and despite the President's simultaneous request that all other nations do likewise. All of these countries are moving to the next step in the fuel cycle regarding waste management, which is vitrification. And finally, all of these countries are therefore in a position to move ahead on storing the vitrified or glassified nuclear waste in permanent repositories, such as underground salt mines.

Therefore, Mr. Speaker, I hope that when you and our colleagues in the House of Representatives, as well as the President of the United States, consider the European nuclear experience during the past few years, you will agree with me that the United States should reopen the reprocessing option because of its implications for better nuclear waste management.

While I intend to return to a more detailed discussion of this and related recommendations for revising our current policies on the commercial use of nuclear power, I now want to report our findings on the tour:

GREAT BRITAIN

During an overview briefing conducted by Sir John Hill, Chairman of the United Kingdom Atomic Energy Agency, we learned that the English accept two basic premises regarding the energy picture: One is that petroleum will become increasingly scarce, and two, it will become increasingly more expensive.

High energy costs have always been factored into their living standards, for example, in the various designs for their cities, which tend to be compact. They expect that overall energy growth rate will be somewhere between 1 and 2 percent per year. This includes a reduction of 25 percent due to the effects of future conservation.

Mr. Hill stated that the English people believe that they need nuclear powerplants; however, they expect the government to make sure that these are safe. And as a matter of policy, reprocessing is desirable both to close the fuel cycle and for the purposes of waste management.

The Department of Environment oversees the waste management effort. They rely on the geological survey for their geological effort and the U.K.A.E.A. for technical advice. The Department of Environment has both the policy role for identifying appropriate waste management approaches as well as the standard setting role for determining the dose levels to be released through the waste management activity. This agency is considering setting up a semiprivate organization to implement the government's waste management effort which will provide the service at a fee to the nuclear industry.

Mr. Hill expressed concern that the American nuclear power program would be losing its young people because the program is in a degenerative state. He felt that the loss of these people would hamper our efforts to restart the program.

Mr. Hill's staff expressed concern at the unilateral way we developed the Nuclear Non-Proliferation Act. They feel this act does not recognize their need for energy security—and puts us in a position of speaking down to our Allies.

The NNPA requirement that any American equipment involved in the fission process used by foreign governments would make the nuclear fuel subject to the U.S. reporting and transfer requirements, was identified by the English as particularly damaging to U.S. equipment vendors' commercial position. They believe that no country would tolerate this level of intervention in their fuel cycle or with their sovereignty.

The United Kingdom has 13 nuclear powerplants on line now, producing 13 percent of its electricity. It is building one new nuclear plant a year for the next 10 years to meet an anticipated 1½ to 2 percent growth in electrical demand. These plants will be 1,300 megawatt and will take 9 years each to build. As plants currently under construction come on line, it is anticipated that nuclear power will produce 20 percent of their electricity by the end of 1981.

Their licensing process includes public comments and hearings, which has added about 2 years to the construction time of a nuclear plant. Their Secretary of State for Energy approves or disapproves a license after hearing all the pertinent information. A Parliamentary debate is possible if the issue is controversial. There is no judicial review.

Their nuclear regulatory framework is divided among the Department of Energy, the Nuclear Inspectorate, and the Department of the Environment. Representatives of these agencies stressed that agreement is always reached between the bodies through organized discussion and debate. And I would just comment that their Parliamentary form of government is conducive to this coordination on major policy issues such as nuclear power.

Britain is working on the breeder reactor, reprocessing of nuclear spent fuel, and vitrification (glassification) of high-level wastes. In the mid-60's at Harwell, high-level wastes were vitrified and stored. These wastes were retrieved last year and determined to be in the same condition. No leakage, dissolution, or disruption was discovered. The British have determined to proceed with vitrification of their high-level wastes, primarily because glassified high-level waste is easier to handle than spent fuel or liquid waste.

In summary, Sir John Hill said the United Kingdom is committed to reprocessing and to the breeder reactor. It sees both as integral and essential to proceeding in an energy-conscious manner to provide domestic energy resources.

Following our briefing in London, the delegation traveled to Scotland to visit the Dounreay Prototype Fast Breeder Reactor and Reprocessing Facility.

In the early 1960's, the United Kingdom foresaw a shortage of energy and a shortage of uranium. The effort at Dounreay has been directed to give the United Kingdom energy independence. The siting of the plant at Dounreay was done with public explanation of the risks prior to the siting of the plant.

The researchers at Dounreay have looked at the accident scenarios resulting from TMI and have determined that there would be no effect on the prototype fast reactor design. They are currently investigating various modes of accidents whereby all power could be lost for all emergency systems. It appears that the prototype fast reactor is a "walk-away" reactor. By walk-away reactor, it is meant that without any hands being on the controls of the machine, it could safely shut down and cool itself with a total loss of power to all systems.

"Probabilistic assessment" was used for the design of the prototype fast reactor system (PFR). The design of each system was subject to a failure consequence analysis whereby dose and events per year were calculated. These calculations determined the basis for the design of each system.

The same people; that is, the researchers who developed the design of the prototype fast reactor, are the people who were simultaneously developing the probabilistic risk assessment methods. It appears that the PFR system has been designed at each stage according to probabilistic assessment methods, rather than using probabilistic assessment methods to see how safe the design is after it is fully completed.

It was pointed out that if the optimization of each element of the fuel cycle is done separately, then when put together, the result may be a system which is highly incompatible. Therefore, the reprocessing scheme as well as the reactor, along with the fuel design, are developed together so that this mismatch does not occur.

The plant displays at the PFR are highly computerized and displayed to the operator on four television monitors. The operator can dial any information directly from the computer to one of the monitors that is strictly for data display.

FRANCE

The Commissariat a l'Energie Atomique (CAE) is the French Atomic Energy Commission, whose basic function is to promote the uses of nuclear energy in science, industry, and national defense. We were briefed on their commercial nuclear programs by members of the CAE and its staff.

France's nuclear program is made easier by the existence of a single utility, Electricite de France. It is a governmental organization which must get a declaration from the Minister of Industry that a nuclear project is necessary to the nation. Public hearings are then held and all information is considered in determining whether or not to issue a declaration. Once a declaration is issued, the only court appeal available is one which shows that issuance of the declaration was procedurally flawed.

It currently takes 6 years to build a nuclear powerplant. Designs are standardized and the same construction company is used. Only site selection differs.

The French currently have five gas-cooled reactors, but these are being phased out in favor of pressurized water reactors—PWR's. They are beginning one PWR every 4 to 6 weeks. Today, 16 percent of France's electricity is supplied by nuclear power. By 1985, the figure will be 50 percent. By 2000, nuclear power will supply 75 to 85 percent of France's electrical needs.

The French view this as a national necessity. Ninety-nine percent of their oil is imported, as is 75 percent of their coal and 66 percent of their natural gas. Thus, national independence is basic to their nuclear program.

They anticipate a 3- to 4-percent annual growth in total energy use and 5- to 6-percent annual growth in electricity consumption. Nuclear power is, therefore, an important domestic resource. This explains their strong emphasis on the breeder reactor, as well as reprocessing, and the vitrification of high-level waste.

France is also making conservation strides. By 1990, energy conservation will be saving 20 percent of the energy used today. French citizens receive tax breaks for using home insulation, take advantage of cheaper off-peak electrical rates, and have a lower per capita use of energy than we do. Further, the French citizen can only get 90 percent of the energy he used last year. A specific tax on oil is levied to increase conservation, a portion of the proceeds going specifically for nuclear power.

The CAE representatives made two final points. The United States is spending the same amount of money on breeder reactor research as France is spending on building them. And we will lose our nuclear experts and expertise if they are not encouraged and given a future of progress.

The first French facility we visited was at Cape LaHague. The LaHague reprocessing plant was initially planned in 1960 and built in 1966 to serve France's domestic gas-cooled reactors. Since that time this plant has been redesigned and upgraded to provide the capability to reprocess light water reactor fuel, for example, low enriched uranium, as well as breeder reactor fuel, for example, plutonium-bearing material, all in the same facility. France's work on reprocessing has been accomplished in tandem with its work on the breeder reactor and its light water reactor program.

The LaHague facility will have enough extra capacity in 1985 through 1995 to service 30 foreign reactors each year for that 10-year period. France has already contracted out this open space on their production line. These contracts are held by Japan, Sweden, Denmark, and Germany among others. After 1995 the French will have no excess capacity and will only be able to serve their own domestic reactor industry.

At the end of 1980, construction is expected to begin on the glassification facility at LaHague that will solidify the high-level waste at the site in a form that will be prepared for permanent disposal. Those countries which have contracted with France to reprocess fuel must take back the fission product waste in a glassified form as part of the contract.

The French facility at LaHague is highly computerized. They have had a main computer analyzing all the parameters from the facility and assisting in its operation for the past 7 years. The displays are on a simplified process diagram and television tube displays.

It was pointed out by the French that our facility at Barnwell at this point in time is an antique, since it no longer represents technology that is either current or, perhaps, even workable.

After the LaHague tour, we next visited the waste vitrification facility (AVM) and the so-called Phenix fast breeder reactor at Marcoule.

The French use a borosilicate glass in the vitrification process. The glass is stable up to 600 degrees centigrade.

The French have found that they burn out the melter pot approximately every 2,000 hours. They have found this is not the cause for real problems with the plant since they can easily replace it in 3 days. This is a low dose maintenance operation.

The entire AVM facility was tested to determine the capability to remotely decontaminate its process equipment prior to its startup. This was accomplished.

The French currently plan to store the glassified waste in the AVM storage holes for about 40 to 50 years. This will permit additional cooling of the glassified fission products so that they can be safely stored underground without concern for the stability of the glass product.

The glass in which the calcined fission products are stored is a mixture in which the fission products are an integral part of the glass.

The French had corrosion problems with the scrubber tank of the AVM. This was solved by changing the normality of the scrubber solution and by altering the materials of which the scrubber tank was made.

While the French do not believe that the glassified product created at the AVM is necessarily the final product, they do believe that the product in this form is in a much safer configuration and will therefore give them more time to determine if there is another form that they wish to store the waste in for ultimate disposal.

The Phenix breeder reactor has been operative for some time and is working well. It has undergone a total station blackout as part of its testing, and it is capable of removing all heat by convection alone. The heat exchangers from sodium to water in the Phenix have never leaked. They are designed to transfer heat in modules, with a total of
modules.

The Phenix has already used and recycled its reprocessed uranium withi
the reactor.

The worst problem that the Frenc
have had with the Phenix is a primary to secondary heat exchanger leak. This was determined to have occurred due to faulty design in the upper head which was subsequently corrected in all the heat exchangers. The problem, however, required them to demonstrate that a major component that had operated in the reactor for almost 3 years would be pulled and decontaminated so that it could be worked on directly by plant employees. This was done successfully. The total dose to the workers was a maximum of 36 millirem and the peak dose rate was 30 millirem per hour; the total manrem from this operation was 17.

For the Phenix reactor the French have identified six key safety parameters which are grouped on the console directly in front of the operator. The operator also has all alarms immediately displayed to him on a television-type display.

Following this visit, we traveled to Creys Malville to inspect the new a
much larger breeder reactor which
under construction, the so-called Super Phenix. Its cost is approximately twice the dollars per kilowatt that an equivalent light water reactor would be. This, however, includes the cost of R. & D. as well as the cost of many items associated with the first-of-a-kind design. It is expected, however, that the cost of subsequent units will greatly decrease.

The Super Phenix project is totally of French design, and managed by the French, although there is some financial participation by Germany, Italy, England, and several other European countries.

The major departure of the Super Phenix design from previous experience is in the design of the sodium steam generator. This steam generator has been tested at actual operating conditions for 2,000 hours on a test stand. They are currently tearing this steam generator down to see the metallurgical results of this operation.

The Super Phenix, instead of having one 1300 megawatt turbo generator, will have two 600-megawatt turbo generators. This is because the French did not wan
to experiment with larger designs wi
which they have no experience.

The Super Phenix has three separat
and independent reactor shutdown sy
tems. One of these systems is compris
of three segmented control rods whi
can be inserted into a core that has be
highly physically deformed.

The Super Phenix has been designe
with a core catcher in the event of a core meltdown. This would assure that the molten core would not come in contact with the primary vessel and would

be in a position to be cooled by sodium that is routed through the core catcher.

The French have not made extensive use of probabilistic assessment in the design of the Super Phenix, except for the design of the reactivity control system; that is, three separate shutdown systems. This is because they believe that this is the most critical point in the safety of the reactor.

The French believe that the most critical aspects of reactor safety are good basic design of the machine, good operating practice, and good maintenance practice.

The Super Phenix currently employs about 1,400 construction workers. During operation 300 people will be required.

The fuel cycle of Super Phenix requires that it be shut down once a year for refueling and inspections. The machine will have a breeding ratio of 1 to 2.

Before leaving France, we discussed general energy issues with representatives of the International Energy Agency. What follows are some general impressions of their views:

Conservation, coal, and nuclear energy sources must be used to reduce the pressure on oil in the next 10 to 15 years.

The Europeans see governmental ambivalance in our path toward nuclear power. They are concerned that this ambivalence will cause a destruction of the personnel-oriented infrastructure that supports the nuclear power industry in the United States.

The IEA has not done an independent study on uranium supplies; however, they believe that, while there is probably enough uranium in the world to go around to fuel reactors for the next 30 to 50 years, it would be imprudent to base one's fuel availability projection or build one's program on the basis of assuming that this fuel will in fact be available.

One perception that the IEA has of the French is that the French are concerned that if the United States does not get in with a heavy commitment to nuclear power, many of the European nations will have to undergo increased public pressure and questioning on the safety of their programs. This is because the population will be concerned with the question: If it is safe, why is not the United States doing it?

The Italians have hit their IEA trigger point for receiving assistance from member countries with their supply of oil. The IEA staff expressed concern that the system of assistance will not work if activated.

GERMANY

Germany is by far the least developed country we visited, in terms of nuclear power. Currently only 10 percent of Germany's electricity is supplied by nuclear power. By 1985, that figure will rise to 15 percent, and by 2000, it will be 25 percent. Several away-from-reactor storage sites will be established, although Germany is dedicated to using the breeder and reprocessing. Reprocessing will both reduce the amount of nuclear waste to be disposed of, and increase the productivity of the uranium, 100 percent of which Germany must import.

Although the use of nuclear power is a federal decision, the local governments have what amounts to a veto over nuclear projects. As a result, the proposed nuclear center at Gorlebun in Lower Saxony has been held hostage to political considerations, although all agree as to the center's safety aspects. If completed, the center would contain thermal reactors, breeders, reprocessing of spent fuel, vitrification and final disposal all at one site. Judicial review is also very important in Germany.

We first met with representatives of the German Ministry for Research and Technology to get a briefing on their commercial nuclear programs. They have tried to colocate reprocessing and final disposal facilities at the same site.

The fuel cycle will be in "private hands" except for the final disposal of nuclear waste.

Gorleben, a potential site for final disposal and reprocessing, is hung up for political reasons by the State of Lower Saxony, although the site has been found to be satisfactory on the basis of all technical considerations.

All reactor licensing has been conditioned on resolving "the back end" of the fuel cycle—this has now become the focal point of the opposition movement; that is, the back end of the fuel cycle.

The Germans believe that the best way to dispose of spent fuel is to reprocess it. This is not necessarily economic; however, it is the safest way to dispose of the fuel since it separates out plutonium from fission products. Thus, the waste decays to harmless levels in 1,000 years.

Recycle of plutonium in light water reactors results in reprocessing a waste that would otherwise approach radiation levels in natural uranium ores after 1,000 years of decay. This is due to the fact that plutonium would not be present in these wastes.

The greatest concern in long-term storage is that there is no plutonium being put into the ground. This would change the radiation consideration from 1,000 years to millions of years.

The Germans have determined that the recycle of plutonium of light water reactors would improve by 30 per cent the utilization of uranium, all of which is imported. The Germans believe this is a significant conservation item.

The "back end" of the fuel cycle has been decoupled from the breeder. The issue of the breeder will be decided by a separate government proposal.

Ten percent of German electricity is currently produced by nuclear power, 15 percent will be nuclear in 1985, 25 percent is expected by the year 2000.

In Germany, lignite is the cheapest form of baseload power. Nuclear power competes with lignite in Germany, not oil.

Eight percent of all oil used in Germany is used in the production of electricity. They intend to reduce this consumption of oil.

Germany mines 100 million tons of coal a year. Use of the entire coal production for synthetic fuels would result in a maximum reduction of imports by 25 percent.

The political problems with nuclear power are linked to upcoming elections in which it is being used as "created issue," but it is not a primary issue.

Germans, of course, recognize that worldwide uranium supplies exist; however, they are unsure that these resources will be available for political reasons.

The Germans feel that a free economic exchange between countries would ease problems with uranium. This would lessen the need for the breeder. However, the current trend of nationalism is ending all of this.

We visited the permanent waste disposal facility at Asse. It was originally built in 1906 as a salt mine. It was bought in the mid-1960's by the German Government as a test laboratory for the storage of disposal of radioactive waste. The German entity that owns and operates Asse is a group called GSF, which is similar to our Oak Ridge National Laboratories.

The salt in Asse is 200 million years old; the geological anticline that the salt is located in is 100 million years old. This formation has been stable that entire period of time, 100 million years.

The purpose of Asse is to develop the technology for the storage of low-level, intermediate-level, and high-level waste. High-level waste will be stored in solid form. The Germans do not consider spent fuel to be waste.

The United States has a bilateral agreement with Germany to do testing in the Asse Salt Mine. The purpose of this testing is to provide base-line data for existing U.S. computer codes on rock mechanics.

To date, 125,000 55-gallon drums of low-level waste have been stored in Asse. This low-level waste comes from nuclear medical programs, as well as nuclear powerplants.

Thirteen hundred 55-gallon drums of intermediate-level waste have been disposed of at Asse. The intermediate-level waste is the reprocessing waste from Karlsruhe Research Center. These wastes contain cesium, strontium and actinides. The dose rate limit for wastes put into the Asse Salt Mine is 200 millirem per hour at contact with the surface of the drum. This is also the requirement for the low-level waste.

The salt has excellent characteristics for disposal of waste. The fact that it exists intact demonstrates that it has not had contact with water for geologic periods of time. Salt dissipates heat from radioactive waste very well and is highly plastic, which would cause cracks to be "self-healing."

Tests are being currently run at 200 degrees centigrade on the salt. This consists of boring test holes in the rock and using electrically powered heaters to measure such things as convergance, the amount of moisture driven out of the salt, as well as the heat dissipation capability of the salt.

The thermal tests that are currently being run are being performed at a power density of 60 watts per liter, although the actual storage will be at 40 watts per liter. In this testing, convergance testing is being done on the salt.

Convergance is the term used to describe the capability of salt to "flow" and reheal itself in the event of cracking. It is this phenomenon that the scientists anticipate will cause salt to reseal itself around radioactive waste that is stored in mines.

The Germans inspect sample lots of drums before they are stored to assure that there is no water present. If any water were to be found, the drums would be banned from storage in the mine.

The Karlsruhe Research Center was founded in 1956. It has 3,200 employees and occupies 1 square mile. The research center performs West Germany's basic research on breeder reactors, reprocessing, and reactor safety.

In 1967 through 1970, the WAK reprocessing plant was built; they have reprocessed LWR fuel with up to 30,000 megawatt days per ton burnup. This plant has processed a total of 165 metric tons, and is capable of a maximum of 40 tons per year.

DWK is the company that has been set up by German utilities to complete the "back end" of the fuel cycle. The Germans will build a French AVM—the type of vitrification facility at Marcoule—at Karlsruhe to solidify 14 cubic meters of waste they have at the site. They believe it can be licensed in Germany. However, they cannot build their own facility because of licensing problems. The licensing people will not permit the facility to be built until certain basic questions are answered. However, the German authorities pointed out that they cannot get the information until they build the facility. Therefore, they are going to build the German facility for Eurochemic in Mol, Belgium.

The WAK reprocessing plant was built as a pilot plant to experiment and develop techniques and data on reprocessing. The facility has a very complex control room, which provides direct readouts and direct alarms based on plant flow schematics.

Experience at the German reprocessing facility has been essentially with light water reactor fuel. The German experience with vitrification has been limited to dummy runs on a simple rig. It does not involve the use of any radioactive material.

The German vitrification machine that will be built at the Eurochemic facility in Mol, Belgium, will utilize an integrated calciner, glass frit mixing chamber. This chamber will require replacement every 3 years at a cost of about $2 million. It is expected that the cost in manpower will be very expensive. However, the machine is expected to be an efficient, continuous processing machine when it is running.

The German prototype vitrification machine is far more complex than the French AVM and appears to have much less testing behind it. The prototype of this machine, however, has not been tested with radioactive material.

The German nozzle enrichment technique is currently being incorporated in a plant being built in Brazil. The German nozzle enrichment technique can produce a plant at half the capital cost of a gaseous diffusion plant. It will have approximately the same power requirement.

Our last stop in Europe before returning to the United States on January 16 was at the Alkem Fabrication Plant in Hanau, West Germany.

This plant has handled plutonium fabrication for 17 years. It employs 400 people. It has handled 17 tons of plutonium in these years. The facility has fabricated 25 tons of nuclear fuel. They are currently fabricating fuel for Germany's first prototype fast reactor that is under construction.

Up to one-half mile outside of the plant virtually no plutonium has been found that is due to the operation of the facility. The overriding concern of Germany is to minimize the amount of plutonium in spent fuel and outside the core of the nuclear reactors.

The objective of thermal recycle, that is, the recycle of plutonium in light water power reactors, is to close the fuel cycle without using a breeder reactor.

The points against long-term storage, that is, long-term risk due to the storage of spent fuel, are:

Long-term storage makes plutonium more accessible each year, due to the continuing decay of the fission products.

Long-term storage requires the storage of fissionable material in a burnable cladding, that is, zirconium, which serves as the clad for most fuel rods, is burnable.

The storage of spent fuel involves the storage of pressurized fission product gases within the fuel pins. These fission product gases are under a pressure of 30 atmospheres and present a potential risk to health and safety if they were to suddenly release the gas.

Thermal recycle of plutonium in light water reactors would reduce the enrichment requirement for uranium in light water reactors by 25 percent at the equilibrium cycle.

On an economic basis, the economics of thermal recycle are marginal, but for environmental and proliferation reasons, the need to reprocess exists. Because of safety reasons, on the balance, to reprocess plutonium is a plus. The Germans do not believe that plutonium should be put in the ground as a nuclear waste.

They argue that to give up the recycle of plutonium in light water reactors is to give up the incentive for improvements in light water reactor fuel performance. The need for a breeder ultimately will be paramount, according to officials at this facility, as uranium supplies dwindle.

The basis of security in plutonium storage is: man, method, machine, and material. The detection devices that are utilized in the security of plutonium bunkers are devices that can detect up to one-tenth of 1 gram of plutonium on entry or exit from the plutonium labs. Thus, a man could work his entire lifetime at the plant and never steal enough plutonium to make a critical mass.

The Germans believe that a plutonium explosive device is far more difficult to develop than an enriched uranium device. They believe that the security systems must not restrict civil liberties excessively. Government agencies perform the background check for employees who are employed as guards or workers within the plutonium facility.

The basis for design of the plutonium facility is that an armed force should not be able to gain access to the plutonium areas for at least one-half hour, and that no plutonium should be able to leave the facility undetected. Drills have been performed whereby within 10 minutes from being notified, 200 to 400 Federal law enforcement people could be on site.

The bunkers that house the plutonium are capable of withstanding the explosion of a 20-kiloton nuclear device 100 meters away. This is because the designers believe that a conventional weapon should not be able to cause a nuclear disaster larger than the disaster that would be caused by the explosion of the weapon itself.

The plant is currently fabricating plutonium fuel for use in light water reactors as well as the first plutonium core for Germany's first breeder reactor which is under construction at Kalkar.

Mr. Speaker, because of the nature of our tour of the aforesaid facilities, this has been an extensive report, and because I will have much more to say on the subject in the coming debates on U.S. commercial nuclear policy, I will close with just a few brief observations.

I think the legislative objectives of the inspection tour were realized, because we saw firsthand that our European allies are taking concrete steps not only to use nuclear power in solving the current world energy crisis, but more importantly from the standpoint of my personal objectives, they are moving ahead with specific, technological programs to reprocess the spent fuel so that the high-level radioactive waste involved can be separated and put into a safe, stable form ready for permanent disposal. Moreover, they are moving ahead toward ultimate disposal of this waste by not just looking for permanent disposal sites, but by actually storing nuclear wastes and testing this experience at the same time.

Mr. Speaker, not only for the purpose of getting more efficient use of the known sources of uranium, but also of immediate concern to us, the English, the French, and the Germans have found that reprocessing spent nuclear fuel is the key to nuclear waste management. I think the time has come for the United States to face up to the same reality.

Congressional Record

INFCE I

HON. TOM CORCORAN

OF ILLINOIS

IN THE HOUSE OF REPRESENTATIVES

Monday, March 24, 1980

● Mr. CORCORAN. Mr. Speaker, I reported to the House on February 20 my observations about the activities currently being conducted in Europe relative to that area's approach to uranium resource conservation, as well as nuclear waste management. A few days later, the International Fuel Cycle Evaluation (INFCE) concluded its work and presented its report in Vienna, Austria. This 66-nation international effort was convened at the suggestion of the United States as a result of President Carter's actions pursuant to his April 1977 nuclear policy statement. In the midst of other urgent international developments, the importance of this meeting and the conclusions of its participants have been blurred. Under normal conditions, the caption for the article describing the outcome "66-Nation Group Rebuffs Carter, Backs Breeder Reactors" might have been front page material in the Washington Post. Unfortunately, this article was buried back on page A 12 and received relatively little attention. I am inserting this article at the conclusion of this statement so that my colleagues may have an opportunity to review issues raised by INFCE which I feel are important to decisions soon to be before Congress about the reorientation of our domestic nuclear policy. Additionally, I am inserting a February 29 article from the International Herald Tribune.

The unfortunate situation in which we find the United States at the conclusion of this 2½ year effort is that we see yet another aspect of our failed foreign policy drifting without any true focus on productive conclusions. U.S. nuclear policy is unquestionably driving our European allies to the Soviet Union for enriched uranium. Without a doubt, the United States is increasingly in a position of standing alone in terms of nuclear energy policy.

If we reflect on the important decisions Congress has faced since the Carter administration assumed office, we can find that the conclusions of INFCE, which was convened under pressure from the President, have indeed vindicated the Congress. We in the Congress have been called upon several times to confront the Carter position on the deferral of spent nuclear fuel reprocessing and breeder development in this country. This body has continuously rejected the notion that vital elements in our domestic energy policy should be scuttled because of the mind-set developed early in this administration. We have rejected these proposals to eliminate the United States as a participant in the peaceful applications of nuclear technology. At issue for us now is whether or not the administration has the courage to respond to its proper commitment—to accept the basic conclusions of this international study, in which the United States was a full participant, and proceed to restructure the domestic nuclear fuel cycle program that has been devastated by various initiatives undertaken by the administration since 1977.

I submit that the financial costs alone to the American people for this experiment in foreign policy by the Carter administration have been very high. These costs can be measured in terms of the cancellation of nine enrichment contracts which would have provided important trade revenue benefits of up to $1 billion. These costs can also be measured in our inability to participate as a supplier of equipment for the legitimate energy programs of other nations. These costs can be measured in terms of the delays in the completion of important steps in our breeder demonstration program which has added at least 3 years to the availability of the first operational information from the Clinch River breeder reactor demonstration project adding at least $300 million to the cost of the project as a result of inflation. These costs can be measured in terms of serious erosion of the private sector to begin reprocessing fuel by no later than this year amounting to perhaps a penalty of $250 million in the costs of each such facility. These costs can be measured in terms of the numerous studies performed in connection with this international program, $24 million of which has been poured into a nine-volume Department of Energy report called the nonproliferation alternatives systems assessment program. Finally, 38 percent of the direct costs of INFCE were borne by the United States. These direct costs represent direct assessments to administratively support INFCE and do not include the additional costs borne by the U.S. Government in support of the U.S. delegation which attended various INFCE meetings, all but one of which were in Vienna. By this crude accounting, this experiment by President Carter has cost U.S. citizens at least $3 billion and some 3 to 5 years in implementation of important programs—to say nothing of a most severe erosion of U.S. prestige abroad.

I have carefully reviewed the 72-page INFCE summary volume. I have also met in my office with the U.S. Ambassador to INFCE, Gerald Smith. I would like to invite the attention of my colleagues to the following quote from the INFCE summary volume.

> Reprocessing in itself is important because it is an essential preliminary to many of the possible fuel cycles . . . if the breeder developing nations (who are also currently large users of uranium) install breeders on a sufficient scale, the rate of increase for the uranium price could slow down as these nations reduce pressures on the uranium market. If such a large-scale deployment can take place, it is likely not only that a light-water reactor and other thermal reactors will continue to be an economically viable option, but that uranium supplies would be redistributed to the benefit of countries with developing nuclear programs. Similar considerations would apply for other advanced reactor systems and fuel cycles.

Mr. Speaker, our obligation is to take the steps necessary for the United States to resume its technology leadership role. The worldwide application of both reprocessing and breeder technology should have the full benefit of U.S. input on matters of public health, safety, and safeguards. Anything less would be irresponsible.

Mr. Speaker, for the benefit of my colleagues, I insert a February 26 Washington Post article by Milton R. Benjamin and a February 29 International Herald Tribune article by Don Cook:

[From the Washington Post, Feb. 26, 1980]

A 66-Nation Group Rebuffs Carter, Backs Breeder Reactors

(By Milton R. Benjamin)

Vienna, February 25.—A 66-nation nuclear conference today rebuffed President Carter's appeal to curb international use of fast-breeder nuclear reactors. The conference instead adopted a technical report strongly supporting rapid development of breeder technology.

The report adopted today would appear to vindicate foreign countries that have forged ahead with breeder programs. With several Republican presidential candidates clearly on record as favoring development of an American breeder, the new report could make the advanced reactor an election-year issue.

The study, carried out as part of the International Nuclear Fuel Cycle Evaluation, which opened its final session here today, concludes that fast-breeder reactors would release less radioactivity into the air than existing atomic plants and would also expose the operators of nuclear power plants to smaller radiation doses.

The report cited a number of other ecological and environmental advantages for fast-breeder reactors as well. In the climate of concern over nuclear safety that has existed since the Three Mile Island accident, it seems likely to reopen the debate over the fast-breeder reactor program in the United States.

President Carter, in organizing the international body's study in 1977, sought to kill construction of a U.S. demonstration fast-breeder reactor at Clinch River, Tenn., and tried to persuade other countries to slow up their breeder programs as well.

The president argued against the spread of fast-breeders—so called because they breed more plutonium fuel than they use—out of concern that a sharp increase in the worldwide availability of plutonium, which can be used to fabricate atomic bombs, would add to the problem of curbing nuclear proliferation.

But France, Britain, the Soviet Union, Japan and other countries have pressed on with their fast-breeder programs, and Carter has been unable to kill the Clinch River project. Backers of the breeder have each year pushed funding to keep Clinch River alive through Congress, voting an additional $172 million for the project in September by tacking a rider on a federal payroll bill.

Among the advantages cited for the fast breeder in the report:

Radioactive releases.—"During the normal operation of a power reactor, there are minor releases of radioactivity into the environment in the form of both gaseous and liquid effluents, there is some evidence to suggest that there may be a difference between the two systems, with the fast reactor appearing to demonstrate a clear advantage."

Radiation exposure.—"Occupational exposure should be lower for fast-breeder reactors than for [existing] reactors. Some European utilities are relying on the future fast breeder to decrease the annual dose per operator to well below the figure for the [existing] stations."

Thermal pollution.—"The thermal efficiency of the fast-breeder reactor is higher than that of the [existing] reactor because the fast breeder operates at higher temperatures; the problems of thermal pollution are therefore reduced."

Nuclear waste disposal.—"More [illegible] would be expected to arise from the [ex[illegible]ing] power cycle than from the fast-breeder cycle . . . This decrease would require fewer waste handling requirements and, consequently, less permanent storage capacity."

Even members of the U.S. delegation taking part in the fuel cycle talks here concede that the breeder reactor probably would reduce the number of occupational deaths associated with the nuclear industry, since it largely operates on plutonium and thus would reduce the need for the uranium that fuels existing atomic power plants.

A U.S. official said uranium mining is the primary cause of fatalities in the nuclear energy industry.

U.S. officials decided not to dissent formally from the study's general endorsement of breeders for countries with large electricity requirements. They made it clear, however, that they feel the report is too one-sided.

"The need and prospects for breeders understandably are given considerable attention in the light of their promise and the interest that some nations have in this technology," U.S. Ambassador-at-Large Gerard Smith said in addressing the session today.

"But the breeder is not without its costs, risks, and uncertainties," Smith added. "That report focuses much more on the positive features of the technology."

The United States did express satisfaction—from a nonproliferation viewpoint—that the report states that "breeder development and deployment is not likely to be economically attractive to countries with a small number of nuclear power plants, or just embarking on such a program."

In an earlier development, the conference delegates, in a last-minute compromise, elected Y. Yatabe, Japan's chief delegate to the talks, to be president of the group's final session.

Sir Hermann Bondi of Britain had been tapped informally to be president, but the group of 77—representing 117 Third World nations—over the weekend objected to selection of a delegate from a nuclear weapons country to chair the gathering.

[From the International Herald Tribune, Feb. 29, 1980]

World Body Endorses Nuclear Power Despite Weapons Proliferation Risk

(By Don Cook)

Vienna, February 28.—An international technical conference concluded yesterday that world nuclear energy development must be continued despite the danger of the spread of nuclear weapons.

It set forth this priority in a communique ending a two-year evaluation of nuclear fuel problems that resulted in an exhaustive series of technical studies.

The 66 countries involved in the International Nuclear Fuel Cycle Evaluation agreed that effective measures can and should be taken to minimize the danger of the proliferation of nuclear weapons. But they also agreed that such measures had to be applied without jeopardizing energy supplies or the development of nuclear energy for peaceful purposes.

The technical studies themselves endorsed both the development of fast-breeder nuclear reactors, which run on plutonium, and the reprocessing of used nuclear-fuel rods. Both moves will increase the amount of weapons-grade plutonium in the world. But the studies found the steps necessary to improve the world's energy supply.

FRANCE FAR AHEAD

As the meeting ended, the nationalized electricity authority of France announced in Paris that it would place orders for two large fast breeder reactors, each capable of producing power in the 1,200-megawatt range. France is already far ahead in fast-breeder development, with completion of a 1,200-megawatt plant due to begin operation in 1983.

The conclusions of the INFCE study pose some policy questions for the Carter administration, which, in 1977, began an effort to alert the world to the dangers of weapons proliferation inherent in the growth of nuclear power.

When President Carter took office, he stopped work on construction of a big U.S. reprocessing center and tried to halt fast-breeder development. He also drastically tightened licensing procedures and controls over exports of enriched uranium.

The hope of the administration apparently was to gain consensus on the limitation of nuclear power development.

But as the eight volumes of technical studies and the final communique of this conference conclude, world consensus is that nuclear power development must go forward without being circumscribed or impeded. This position was reached regardless of the fact that there is no foolproof way of having nuclear power without the danger of a weapons spinoff.

The study, in which more than 500 nuclear experts from 46 countries and 5 international agencies participated, thus is more of an endorsement of European attitudes toward nuclear power than of the U.S. approach.

The U.S. nuclear industry is in the doldrums as a result of the Carter policies, the Three Mile Island accident, anti-nuclear lobbies and regulatory red tape, while in Europe nuclear power is still generally pushing ahead.

Europe now derives nearly 50 percent of its supply of enriched uranium for its power stations from the Soviet Union, whereas only 10 years ago, the United States was the monopoly supplier. The constant change of U.S. policies over supply arrangements is certainly a factor in this shift.

Since there are no specific recommendations resulting from the two-year INFCE study, it will be up to each government to develop its own policies in the light of the technical reports.●

Congressional Record

INFCE II

HON. TOM CORCORAN

OF ILLINOIS

IN THE HOUSE OF REPRESENTATIVES

Tuesday, March 25, 1980

• Mr. CORCORAN. Mr. Speaker, yesterday I made a statement to my colleagues on a matter of important international consequence, the conclusions reached by the International Nuclear Fuel Cycle Evaluation (INFCE) regarding the importance of nuclear technology. As I stated then, I felt it was unfortunate that the press account of the conclusions of this 2½-year, 66-nation effort was buried deep and received very little public attention. The Washington Post attempted to rationalize in a March 3 editorial position that the outcome of this effort was "a modest success." It is difficult to imagine that this Carter-promoted activity, which in effect led to a 65-1 vote against the U.S. position, can be claimed as a "modest success," yet the attitude assumed in the Post editorial resembles the mind-set that has been prevalent since the early months of this administration. I do not see how one could fashion even a mild diplomatic victory out of this outright rejection. But now, before us, is the challenge of recovering some of the erosion of our international posture prior to the next economic summit in June and the Nonproliferation Treaty Review Conference in August of this year. This responsibility must be assumed by Congress with urgency.

I would hope that my colleagues would join me in asking this administration whether or not they are prepared to take the steps necessary to reconstruct nuclear energy policy in a manner consonant with the needs of an energy dependent world precariously linked with Persian Gulf resources where the Carter administration now talks about military steps we may have to take to defend the oil fields for the benefit of the free world.

An important perspective of the issues can be distilled from the article I submit below, which summarizes a number of concerns raised by various participants in INFCE. The central conclusion on which a consensus was reached, namely that spent fuel has value, especially to nations with large commitments to nuclear energy, must become the focal point for the review of our current policy. Coupled with this is the recognition that reprocessing of spent fuel is important to recover the value in this fuel as well as to enhance our ability to manage the small amount of high-level waste included in this spent fuel. An argument over the relative economics of the value of this fuel has been put forward by the United States in an attempt to justify the current administration position.

The following article addresses this from a number of perspectives and puts this issue into proper context. There are a number of conditions under which decisions to reprocess and recycle material will be made, based on the macroeconomics of the overall impact on the cost of uranium supply. Yet other decisions will be made on the basis of the asset that reprocessing represents to waste disposal coupled with the importance of energy resource conservation. It is distressing to me that this administration would use the free market economics argument when it was its unilateral initiative which resulted in the shutdown of the Nuclear Regulatory Commission's licensing proceedings. The propriety of a member of the White House staff contacting an independent regulatory agency, namely the NRC, to force termination of a public licensing process is highly questionable. Thus, this administration eliminated the only vehicle for the free market system to seek its own level. This maneuver suggests that some members of the administration may have believed that the outcome of the proceedings before the Nuclear Regulatory Commission could have provided substantial arguments directly contrary to policy. Members of at least one of the special interest organizations opposed to this policy and a participant in the proceedings before the NRC now occupy key positions in the Council on Environmental Quality, the Justice Department, and the Environmental Protection Agency. This vested interest is cause for even greater concern since the need to resurrect this issue in the administration may be subverted by internal manipulation.

I subscribe to the recent statement by the National Academy of Sciences in its report, "Energy in Transition: 1985-2010," that "the exacerbation of international competition for access to fossil fuels that could occur in the absence of an adequate worldwide nuclear power program" is a greater threat to peace than a consistent and thoughtful approach to energy applications of nuclear energy technology. The standards for safeguards, public safety, and environmental impacts of the operation of vital fuel cycle facilities should be adopted as U.S. standards. Without a viable demonstration program of the acceptability of our standards as they may relate to the efficient operation of these types of facilities of this nature, it is difficult to imagine that we could ever be credible in insisting on U.S. standards.

Thus, I feel strongly that the time is now to resume the licensing consideration of these matters as well as to press for meaningful demonstration of various facets of this technology at commercial scale. To the extent that it will provide opportunities for other nations to defer commitments of their own, we should also encourage international participation in these facilities. Anything less than this willingness to accommodate the vital international energy security needs of both the industrialized nations of the free world and the developing nations, would be a national tragedy. Should we fail in this effort, there is a strong likelihood that the United States would be cited as the cause for the rejection of the Nonproliferation Treaty by those nations whose energy security interests have been jeopardized by our unilateral policies.

Mr. Speaker, it would be a disappointment to me to address the House again in late August or early September after the June and August international meetings to revisit this issue in an open discussion of what our next step is to be after announcements are made that nations have been forced from their solemn commitments to adhere to the principles and the requirements of the Nonproliferation Treaty.

Mr. Speaker, for the benefit of my colleagues, I would like to insert an excellent summary by Simon Rippon of the INFCE activity that was published in the March 4 Energy Daily:

INFCE's Final Session: Consensus But Not Accord

There is no single nuclear fuel cycle that is wholly proliferation proof. But there also is no single fuel cycle that cannot be reconciled with the need to avoid proliferation. This is one conclusion of the two-year International Nuclear Fuel Cycle Evaluation (INFCE) on which all the delegates to the final conference in Vienna last week seemed to agree.

But it was equally clear from the closing statements of the national delegations that different countries still will draw different conclusions from the voluminous INFCE reports on what is and what is not acceptable in the nuclear fuel cycle.

Those countries that are likely to depend on others for uranium supplies have generally adopted the position—as voiced by West Germany's Hans Werner Lautenschlager—that "Every country will still have to make its own decisions on the peaceful uses of nuclear energy, taking into account [its] respective technical, ecological, economic, political and financial circumstances." And for most of these countries, these circumstances clearly dictate keeping open the option of reprocessing and fast breeder reactors.

The INFCE participants did not contest U.S. Ambassador Gerard Smith's conclusion that "all countries were agreed that the economic advantage of plutonium recycle in light water reactors will at best be small." But several countries clearly deny the accompanying implication that there is no need for thermal recycle.

Notably, the head of the Brazilian delegation stated: "Plutonium recycle in thermal reactors can achieve savings of up to 40 percent in uranium requirements over the once-through fuel cycle, which makes reprocessing an indispensable operation in most nuclear fuel cycles." The Swiss talked of the "well-known advantages" of plutonium recycle in thermal reactors.

And the Belgians—who now own a small reprocessing plant which could be reactivated, who have a mixed-oxide fuel fabrication plant and a great deal of irradiation experience with plutonium fuels in thermal reactors—insisted that the question of whether or not a fuel cycle is economically justifiable "should be left entirely to the country concerned."

More generally, the position of the delegations from the uranium-dependent countries was that INFCE had identified reprocessing as an essential first step in most fuel cycles, and therefore provision for this option should be retained in all long-term supply contracts. This being so, their reasoning went, it is better to reprocess sooner rather than later, or at least to ship spent fuel to a large reprocessing center where it can be stored under an international management scheme.

The three countries with relatively abundant uranium reserves—Australia, Canada and the U.S.—conceded the right of others to decide on their own fuel cycle options. But they noted that INFCE has identified "sensitive areas" of the fuel cycle, and they can be expected to seek improved institutional control over these areas as a condition in bilateral supply agreements.

The efforts of the International Atomic Energy Agency (IAEA) to establish an international plutonium storage scheme (IPS), which have been proceeding in parallel with INFCE, offer the prospect of one such institutional arrangement to deal with the sensitive area of separated plutonium. The fact that IPS was endorsed by the three main uranium suppliers, as well as by all the consumers, was seen as one of the most encouraging developments at the final INFCE conference.

There may be less accord on another sensitive area which was identified in the INFCE report—namely, the long-term proliferation risk associated with spent fuel storage and disposal. The INFCE working group that looked into the question of spent fuel storage noted that while wet storage of low-burnup fuel has been demonstrated for periods up to 20 years; experience with high-burnup fuel is only 10 years and further testing will be required to evaluate longer-term storage.

Many of the conference delegates felt the U.S., Gerard Smith had gone too far with his claim that INFCE had proved spent fuel "can be safely stored on an interim or long-term basis, and terminal disposal without reprocessing appears to be a realistic option for either economic or nonproliferation reasons."

The head of the French delegation, M. de Commines, warned of large accumulations of untreated spent fuel in years to come. Along with delegates from several smaller countries, he advocated a scheme for international management of spent fuel in parallel with international plutonium storage.

Hermann Bondi, head of the British delegation, referring to the report of INFCE's uranium supply/demand group, said: "The overriding message which comes through to us from that report is the uncertainty we all place in planning of nuclear power." He called uranium "the most political of all commodities." And like most of the consumer country delegates, Bondi drew attention to recommended guidelines for long-term supply contracts contained in the final INFCE report.

The hope implicit in these guidelines is that greater predictability can be introduced into conditions of prior consent for retransfer or reprocessing of spent fuel, and that "case-by-case" constraints can be effectively eliminated from bilateral agreements.

To foster a mood that could make this possible, most delegates to the INFCE conference were inclined to play down residual differences of opinion. They concentrated instead on mutual self-congratulation over the fact that 46 nations had agreed on a consensus report without the need for minority views. Nonetheless, last week's final national statements indicate that consumer nations can—and will—draw on plenty of ammunition from INFCE in forthcoming negotiations of international nuclear supply agreements.●

INFCE III

HON. TOM CORCORAN

OF ILLINOIS

IN THE HOUSE OF REPRESENTATIVES

Wednesday, March 26, 1980

● Mr. CORCORAN. Mr. Speaker, now that the dust from the International Nuclear Fuel Cycle Evaluation (INFCE) has settled, it appears that important U.S. allies are taking the steps needed to insure their national energy security. When I visited West Germany in January, the issue of the conditions under which reprocessing of spent fuel would proceed were uncertain. However, I am pleased to bring to the attention of my colleagues the story inserted below which describes progress in this area.

As I reported in my February 20 statement to the House, all German reactor licensing has been conditioned on reprocessing to recover the valuable residual fuel and separating out for disposal the relatively small volume of high level waste. This concept of preference for disposal of solidified high level waste also appears to be a consensus opinion of the INFCE participants. Because of a failure to permit private development of reprocessing facilities, Germany is essentially in the same position as the United States in that interim spent fuel storage away from the powerplants is now required. We must take the steps that will rejuvenate industrial interest in providing both the capital and the expertise to service at least domestic energy needs for the long term. Our future energy security depends on it.

Mr. Speaker, for the benefit of my colleagues, I insert an article by Ann MacLachlan published in the March 18 Energy Daily:

[illegible]

(By Ann MacLachlan)

Things are finally moving on the West German nuclear scene, stagnant in nearly all areas for over three years. Even if it isn't a rash of new reactor orders, or even permission to finish the ones under construction, nuclear industry officials are taking heart from some recent developments in the Federal Republic.

On Tuesday, March 11, the economics minister of the state of Hesse issued a license to the giant utility RWE to install compact spent fuel storage racks at its Biblis A and B nuclear units. The license, which RWE applied for four years ago, is the first to be granted in Germany, although all other nuclear utilities have similar requests pending.

RWE had been forced to operate both units of Biblis (1,200 megawatt PWRs) at 60 percent capacity last year to avoid generating spent fuel that could no longer be stored onsite (and, company officials remark, because the government forced them to buy seven million tons of German hard coal).

The first shipment of Biblis fuel to the French reprocessing company Cogema is not possible before early 1981, so if the compacting license had not been granted, RWE would not have been able to start up the nuclear units after shutdown this month and in May. The compact storage racks have been waiting onsite for months; they will be installed during refueling and maintenance outages this spring, an RWE spokesman said.

With the big Biblis station, RWE generates one-third of the nuclear power produced in West Germany. According to RWE executive [illegible], nuclear power—which it uses for baseload to produce about 11 percent of its generation—costs just about half coal-fired power.

Meanwhile, a first step has been taken toward construction of a German reprocessing plant, also in the state of Hesse and also thanks to the state's economics minister, Herbert Karry. The country's nuclear waste management program had been at a standstill following rejection last year of plans to build a back-end complex for the fuel cycle at Gorleben in Lower Saxony. But Karry, writing recently in the Frankfurt press, stated that since Germany needs nuclear power, and since Hesse has the benefit of the Biblis power, he would accept an application to build a small—up to 350 tonnes per year—reprocessing plant in a depressed area in the north of his state.

DWK, the utility fuel-cycle consortium, submitted a preliminary safety analysis report on February 29; the final report will come next March, according to DWK's deputy manager, [illegible].

Experts in the chemical industry certified that the scale-up from the 35 tonne-per-year test reprocessing plant at Karlsruhe—a factor of one to ten—would pose no problem.

Still to be decided is a precise site for the plant; the state will propose alternatives from which DWK will select a location. Under the most optimistic assumptions, [illegible] said, construction could not begin before 1983 and would last a minimum of six years.

It's not exactly the solution the utilities wanted, compared to the 1,500 tpy plant originally planned at Gorleben, a 350 tpy installation is "totally uneconomic," [illegible] said. He figures per-tonne costs would be as much as three times those of the larger plant. In addition, the smaller plant won't comprise the integrated fuel cycle center that was planned for Gorleben—an approach, [illegible] noted wryly, that has just been endorsed by the International Nuclear Fuel Cycle Evaluation at the same time it is being abandoned in Germany. But the German nuclear industry now has to seize on any technical option that is acceptable to the country's politicians.

The Hesse reprocessing plant would be able to handle the spent fuel generated from German reactors now operating or in the final stages of construction—roughly 400 tpy, [illegible] said, but it would not be sufficient for plants coming on-line through the 1990s. Work must continue on interim away-from-reactor storage as well as on ultimate disposal of either reprocessed waste or spent fuel elements, with a [illegible] decision between the two options planned for the mid-'80s.

One candidate site for AFR storage is at Ahaus in North Rhine-Westfalia, where the government is known for its anti-nuclear stance. Another is at [illegible] in Lower Saxony; just last week, the county council there agreed to review plans for a 1,500-tonne fuel storage facility. Even this AFR, however, would be filled within three years of startup with fuel from reactors now under construction or operating, [illegible] said.

With the test drilling proceeding at the final repository candidate site at Gorleben, there appears to be enough progress toward a demonstrated waste solution to allow continued licensing of German nuclear plants—assuming the current positive trend continues. Federal and state officials, meeting February 28 in Bonn, decided that further licenses will be granted if licensing procedures for a reprocessing plant—or a plant for preparing spent fuel for disposal—have begun by January 1, 1985. Unless the DWK application in Hesse goes awry, this condition will have been met.●

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STATEMENT BEFORE REPUBLICAN NATIONAL CONVENTION PLATFORM COMMITTEE

The SPEAKER pro tempore. Under a previous order of the House, the gentleman from Illinois (Mr. CORCORAN) is recognized for 5 minutes.

● Mr. CORCORAN. Mr. Speaker, earlier today, I testified before the Republican National Convention Platform Committee on Capitol Hill. As a delegate to the National Convention in Detroit, I would like to insert my statement in the RECORD for my colleagues:

TESTIMONY BY HON. TOM CORCORAN BEFORE THE REPUBLICAN NATIONAL CONVENTION PLATFORM COMMITTEE, MAY 8, 1980

Mr. Chairman, Vice Chairman Lott, Members of the Platform Committee:

It is indeed a pleasure for me to have the opportunity to testify before the Republican National Convention's Platform Committee today. The subject of my testimony is energy, especially nuclear energy.

We are at a real crossroads in this country as far as our future energy policy is concerned. The self-defeating federal government regulations on our free enterprise economy are continuing, and in fact, they have been expanded under the Carter Administration. As an example, just the other day, the Department of Energy (DOE) ordered SOHIO to increase its gasoline prices at the pump by 5¢ in order to become more competitive with other suppliers. Not surprisingly, the end of the story is that the DOE order was subsequently rescinded due to political and other practical considerations. Why should this industry, which gambled tremendously in the discovery of new sources of oil in Alaska and was successful, be forced to raise the price to consumers 5¢ per gallon just to come under compliance with these government regulations?

I believe the key to solving our energy problem is increasing American supplies of conventional and unconventional or renewable energies. One way to do this is to use the spent nuclear fuel we already have in storage basins at our nuclear power plants and in away-from-reactor storage pools.

In April of 1977, President Carter ordered the indefinite suspension of advanced nuclear technology research and development on the reprocessing of this spent nuclear fuel and on the so-called breeder reactor project at Clinch River, Tennessee. Congress has challenged the latter part of that decision, and as you know, Mr. Chairman, we have had an annual tug-of-war with President Carter every year since then on the Clinch River project. However, Congress has not yet challenged the President on the reprocessing decision, although I intend to mount such a challenge this year.

The basis for the Carter position on reprocessing is nuclear non-proliferation, as well as a general anti-nuclear view which permeates his Administration. While I disagree with this anti-nuclear position, as do most people in this country, the attempt to limit the proliferation of nuclear weapons is justifiable. And as a means of setting a good example for the rest of the world, the position taken by the President and the Congress a few years back was that we would postpone the reprocessing development of nuclear spent fuel because of the plutonium byproduct involved, which could be used to make nuclear weapons.

However, nobody has followed our example. All the other countries in the world that use nuclear power commercially have opted for reprocessing in order to break their dependence on OPEC oil. For this and many other reasons, I think we should do likewise. Not only should we reassert our leadership in nuclear matters with these other countries so as to have some control on nuclear proliferation and preclude them from going into the Soviet orbit in this regard, but for two other basic reasons, the United States should move forward on reprocessing.

First, it provides a good way to get more energy. For every 1,000 pounds of spent fuel, we can recover out 951 pounds of unused uranium that can be used again in our existing nuclear power plants and in the new ones which hopefully will be coming on line soon. There would also be nine pounds of plutonium produced from a 1,000-pound batch, and this could also be used in our existing power plants. Thus, we would get in this case 960 pounds more energy, which we vitally need in this country.

Second, reprocessing is the key to a credible, safe nuclear waste management program for the United States. In the aforesaid case after the removal of the 960 pounds of new energy, we would be left with 40 pounds of nuclear waste with no energy content whatsoever. Like every other country in the world in this business, we could then vitrify or glassify this waste for safe, permanent disposal in appropriate underground geological formations, such as salt mines.

Therefore, Mr. Chairman, I strongly urge you and your associates on the Platform Committee to write a strong, supply-oriented plank on energy for the Republican Platform, and include in it a call for reprocessing spent nuclear fuel.●

Congress of the United States
House of Representatives
Washington, D.C. 20515

June 2, 1980

Honorable John F. Ahearne
Chairman
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Chairman:

By an Order issued December 23, 1977, the Nuclear Regulatory Commission terminated the proceedings related to the Generic Environmental Statement on Mixed Oxide Fuel (GESMO). This action was taken in response to Administration concerns that the continuation of such proceedings would negatively impact its non-proliferation initiatives, including the International Nuclear Fuel Cycle Evaluation (INFCE), convened in October 1977 at the suggestion of the President to examine alternative approaches to advanced nuclear technologies. The Commission's Order also specifically indicated an intent to "re-examine the (termination order) after the completion of the ongoing domestic and international studies of alternative fuel cycles."

In February, the final plenary session of INFCE was held in Vienna, Austria, and this session marked the completion of a two-year effort initiated by the United States to study the proliferation risks of nuclear energy. Sixty-six countries and five international organisations participated in some form in the INFCE study to which the U.S. contributed 38 per cent of the direct costs. Eight working groups were formed, representing 46 of the countries and all of the international organisations. The INFCE Summary Volume stated not only that "no country with spent fuel arisings has selected the (no reprocessing decision) concept" but also that "reprocessing in itself is important because it is an essential preliminary to many of the possible fuel cycles." In view of the commitment of other countries to reprocessing, it is especially important that the U.S. continue to play a meaningful role in the development and control over this technology, particularly as it relates to energy conservation, safeguards, safety, public health, and environmental standards. Additionally, as you know, the U. S. is facing critical decisions with respect to interim storage of nuclear wastes and spent fuel, and the completion of the GESMO proceedings is essential if we are to be able to make rational decisions based on fact. Regardless of our individual views on reprocessing or other aspects of the nuclear fuel cycle, we believe that the GESMO proceedings must be completed.

Given the completion of the INFCE study and the near completion of the Administration's Non-proliferation Alternative Systems Assessment Program (NASAP), it is now appropriate and entirely consistent with the December 1977 Order for the Commission to initiate the resumption of the GESMO proceedings. The completion of the GESMO proceedings is a necessary pre-requisite under the National Environmental Policy Act which must be satisfied prior to any future Commission decisions related to the possible reauthorization of reprocessing or recycling.

The culmination of INFCE and other alternative fuel cycle studies removes the justification which lead to the original termination of the GESMO proceedings. Maintaining the termination status no longer serves any useful purpose in that it cannot prejudice the outcome of these just-completed studies. The results of the GESMO proceedings will provide valuable information which will aid the Congress in its deliberations with respect to future U.S. non-proliferation policy.

Therefore, the Commission, in order to discharge its duties and responsibilities in accordance with the Mixed Oxide Fuel Order of December 23, 1977, should re-examine the decision to terminate the GESMO proceedings. We are concerned that the Fiscal Year 1981 budget as submitted by the NRC did not reflect the need to resume the GESMO proceedings, and we would like to know the current status of this most important matter.

Sincerely,

Jim Santini, M.C.

Tom Corcoran, M.C.

John W. Wydler, M.C.

Butler Derrick, M.C.

Mike McCormack, M.C.

Dan Marriott

Dan Marriott, M.C.

cc: All Commissioners

Mr. McCormack. Thank you, Congressman Corcoran, for your fine statement.

I can tell you that we will actively consider your proposals for the Committee on Science and Technology to encourage completion of GESMO. Your recommendations are certainly timely and well founded.

You will be pleased to know that the Department of Energy authorization bill, which we have reported out, includes some of the recommendations you have made in the fiscal 1981 budget; especially dealing with waste transfer and disposal and high-level waste glassifications. In addition we have directed the DOE to proceed with its operations and to undertake negotiations for the lease or purchase of the Barnwell fuel reprocessing plant not only for the storage of spent fuel, but also for establishing a multinational nuclear fuel cycle center at the plant. I believe all of these initiatives are constructive.

I am curious to know how you react to the question of what value there is to completing GESMO until U.S. policy is changed with respect to reprocessing or the use of mixed oxide fuels.

Mr. Corcoran. I think one of the misunderstandings that revolves around GESMO proceeding is the impression that to resume it would finalize the decision on reprocessing. That is simply not true.

What we are talking about with the GESMO proceeding is simply a completion of the environmental impact study, which is about 80 percent finished. What we want to do is to complete the record.

It is understandable, I think, why the NRC suspended—and I would choose the word "suspend" rather than "terminate"—the rulemaking proceeding in December 1977. At that time, if you will recall, the President was attempting to exert leadership with other countries on the question of nuclear proliferation. The idea then was to set an example.

Well, of course, as I think most objective observers would now conclude, that example certainly was not followed. As I pointed out, and as you pointed out in your opening statement, other countries have moved ahead with the development of nuclear technology, including reprocessing. And so what we want to do with the GESMO proceeding is simply get questions concerning its impact on the environment and on health and safety answered.

I think that is independent of the foreign policy question of whether or not we want to develop additional institutional safeguards, additional controls, or terminate the reprocessing technology altogether. When you get into that debate, of course, you have to look at what influence the United States has had already in pursuing that policy, as against what might be expected were we to pursue that policy. That is a foreign policy issue, and I think it has to be debated on its merits.

But here the question is with GESMO: Are we going to be able to complete the record? Are we going to be able to find out the pros and cons on an environmental basis, on a health and safety basis, of this new technology? I think we need that information before we can come to a final conclusion on the other subject.

Mr. McCormack. In that regard, what personal input have you had from foreign officials which would reflect their view of current U.S. policies on advanced nuclear technology?

Mr. Corcoran. I recall some discussions we had with the officials of the British equivalent of our Nuclear Regulatory Commission in which they pointed out that a contract they presently have with Westinghouse will probably be terminated altogether and not renewed because of the impingement of the nonproliferation treaty here in the United States on those kinds of contracts.

The impingement is that because of the requirements of signing the international treaty, as well as being open to inspection on the disposition of the plutonium, they simply are restricted to the point, both in England—and they pointed out this was true in other countries as well—so that they would prefer to go to some other country or to go to some other supplier who would not be so restrictive, who would have a contract which could not at some point during the duration of that contract be terminated.

And so the unfortunate bad faith implications of the impact of our treaty at the moment and our legislation is something, I think, that from the standpoint of foreign officials needs to be reviewed. And I am looking forward to that debate next year.

Mr. McCormack. Thank you very much.

Mr. Wolpe.

Mr. Wolpe. No questions, Mr. Chairman.

Mr. McCormack. I have one more for you then.

Would you care to comment on the impact that the INFCE delay has had on the domestic nuclear industry within the United States?

Mr. Corcoran. Well, I am not nearly the expert on that issue that you would be, Mr. Chairman, but from what I understand, it has had quite a negative impact, I think first of all, from the standpoint of scientists, nuclear engineers and others. They see the field as a deadend field because of that uncertainty. And so we are seeing a reduction in the number of students going into the field.

Second, when we look at what the companies are doing themselves, I think we see a shutdown to some extent in the advancement of their own work in the field of nuclear technology. And I think, in general, when you look at the export implications, particularly the ones to which I referred a moment ago, that you also see a further diminution of support and activity and resources in the corporations going to those activities.

It is an unfortunate development at a time when I think the United States is jeopardized by a technology lag, is jeopardized by serious trade imbalances and other difficulties, that are traceable, unfortunately, to erroneous Government policies.

Mr. McCormack. Thank you very much, Congressman Corcoran, for your testimony today. We will be looking forward to working with you, especially on the floor of the House, in the weeks to come.

Mr. Corcoran. Thank you.

Mr. McCormack. Our next witnesses are Ambassador Gerard Smith, who will be accompanied by Dr. George Rathjens. Ambassador Smith is U.S. Special Representative for Nonproliferation Matters and Ambassador at Large.

Ambassador Smith was head of the U.S. delegation to the INFCE proceedings and has played an extraordinary important role in its completion. Mr. Smith's prior experience includes having been director of the Arms Control Disarmament Agency and chief of the U.S. delegation to SALT.

Dr. George Rathjens is the current Deputy to U.S. Special Representative for Nonproliferation Matters and is a professor of political science at MIT. In these positions, Dr. Rathjens has played an active part in INFCE.

I am looking forward to statements by each of you gentlemen. I understand you wish to complete both statements before we have questions from the subcommittee.

We have your statements before us, and you may proceed as you wish. We want to welcome you here today.

[A biographical sketch of Ambassador Smith and Dr. Rathjens follows:]

Hon. Gerard Smith

The President today announced that he will nominate Gerard C. Smith, of Washington, D.C., to be United States special representative for non-proliferation matters; to be ambassador at large while serving in that capacity; and to be U.S. representative to the International Atomic Energy Agency (IAEA).

As special representative for non-proliferation matters, Smith will be responsible for coördinating preparation of executive branch studies, policies, and positions on the issues to be covered by this international effort, and for carrying out negotiations and discussions here and abroad. The President has directed the heads of the U.S. departments and agencies concerned to give full support to this work.

Smith's responsibilities will also include coordinating and guiding, under the direction of the Secretary of State, overall U.S. efforts internationally to carry out non-proliferation policies, and he will be responsible for negotiations to that end. The President is nominating Smith as U.S. representative to IAEA in view of the important role which that agency plays in non-proliferation matters.

In announcing Smith's nomination, the President stressed that international measures aimed at stopping the spread of nuclear explosives capabilities are of paramount importance to the security of this nation and the world.

Smith was born May 14, 1914. He received a B.A. from Yale University in 1935 and an LL.B. from Yale Law School in 1938. He served in the U.S. Army from 1941 to 1946.

After practicing law in New York City from 1946 to 1950, Smith joined the Atomic Energy Commission as a special assistant. From 1954 to 1957 he was special assistant to the secretary of state for atomic affairs. He served as director of the State Department's Policy Planning Staff from 1957 to 1961.

From 1969 to 1972, Smith was director of the Arms Control and Disarmament Agency and chief of the U.S. delegation to SALT. Smith has been a member of the Washington law firm of Wilmer, Cutler and Pickering since 1972.

George William Rathjens

Presently: Deputy U.S. Special Representative for Nonproliferation Matters, Department of State, Washington, D.C.

1969–Present—Professor of Political Science, Massachusetts Institute of Technology.

Previous positions:

1967–68—Director, Systems Evaluation Division, Institute for Defense Analyses.

1965–67—Director, Weapons Systems Evaluation, Institute for Defense Analyses.

1964–65—Special Assistant to the Director, Arms Control and Disarmament Agency.

1962–64—Deputy Assistant Director for Science and Technology, Arms Control and Disarmament Agency.

1961–62—Deputy Director, Advanced Research Projects Administration, Department of Defense.

1960–61—Chief Scientist, Advanced Research Projects Administration, Department of Defense.

1959–60—Office of the Special Assistant to the President for Science.

Education: Yale University, B.S. 1946; University of California, Ph.D. (Chemistry) 1951.

Personal: Born—Fairbanks, Alaska—June 28, 1925; married—three children.

STATEMENT OF HON. GERARD SMITH, AMBASSADOR AT LARGE; ACCOMPANIED BY DR. GEORGE RATHJENS, PROFESSOR OF POLITICAL SCIENCE, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Ambassador SMITH. Thank you, Mr. Chairman.

I am glad to be here today to testify on INFCE. I am accompanied by my Deputy, George Rathjens, who after a bit will summarize more precisely some of the INFCE results.

The idea of an international evaluation of nuclear fuel cycle issues, particularly of reprocessing and plutonium use, was first raised by President Ford. President Carter formally proposed such an evaluation in April 1977. The idea was also endorsed by the Congress in the Nuclear Non-Proliferation Act of 1978.

Impetus for INFCE came from a number of serious questions and concerns. Most importantly, the Carter administration questioned the assumptions that economic and resource considerations required early deployment of plutonium cycles, both thermal recycle and breeders, and that existing safeguards and controls would be sufficient to control the proliferation risks.

There was reason to doubt some of the conventional wisdom, for example, about the extent of uranium resources; the cost of reprocessing; breeder capital costs; the effectiveness of safeguards in dealing with large quantities of weapons usable material in bulk handling plants; and the adequacy of measures to prevent theft, seizure or abrogation of agreements.

INFCE was designed primarily to gain time to examine questions such as these, to develop a better international appreciation of the energy and nonproliferation implications of nuclear fuel cycle decisions, and perhaps to make progress on new arrangements to control proliferation.

The administration was concerned about the potential of prospective developments for increasing the risk of nuclear proliferation. Of particular concern were plans for the acquisition of sensitive facilities—for example, reprocessing and enrichment—by an increasing number of countries not having evident technical or economic needs for such facilities, and the possibility of early commercial use of plutonium for recycle in thermal reactors.

We believed that a better analytic basis for fuel cycle decisions was needed, and that it was essential to reevaluate nuclear programs in light of proliferation risks and to examine alternative fuel cycles, and technical and institutional means for reducing such risks.

A second purpose of INFCE was to provide a forum for open discussion of nuclear power/nonproliferation issues. These had become increasingly contentious, particularly at the IAEA in Vienna and in the U.N., where the debate was producing a degree of north-south confrontation. The Nuclear Suppliers Group discussions were harshly criticized as an attempt by a small inner group to dictate international terms of trade and generally restrict cooperation and competition.

This atmosphere, if continued, would clearly have resulted in a very bad setting for the 1980 NPT Review Conference. An open international forum was needed.

In undertaking INFCE, it was realized that we could not force our views on the international community. The purpose was, therefore, to provide for mutual appreciation and a common data base.

At the same time, it was recognized that we would have to play a leading role and that our domestic fuel cycle policies should take account of INFCE results. The NNPA specifically provides that its provisions shall not prejudice open and objective considerations of INFCE's results.

It was also recognized that technical discussions could not resolve all outstanding issues, and that the wide spectrum of views held by participants would necessarily have to be reflected in the INFCE reports. We recognized the risks of using a broadly based technical forum for discussions involving sensitive political, economic and security considerations. National policy differences might have provoked a confrontation rather than the desired objective dialog. Expectations about results might have been raised beyond those realistically possible.

The administration felt, however, that the opportunities of an open international discussion outweighed these risks. We believed that most countries shared a common nonproliferation goal, and that differences among governments were, in part, attributable to lack of a common data base and analytical framework and lack of attention to certain factors.

We hoped INFCE might help provide a common background for resolving issues and developing common approaches, consistent with nonproliferation, to the development of nuclear energy through the end of the century.

The INFCE organizing conference included all of the key countries, whether NPT or non-NPT states. INFCE's usefulness was enhanced by this broad attendance. The communique of the organizing conference said, in its key passage, that the participants were "convinced that effective measures can and should be taken at the national level and through international agreements to minimize the danger of proliferation of nuclear weapons without jeopardizing energy supplies or the development of nuclear energy for peaceful purposes."

It should be pointed out that acceptance by this broad group of the importance of nonproliferation and that measures were needed to deal with the problem was in itself an achievement.

The communique also emphasized that participation in INFCE should not be taken as agreement to any halt or change in planned programs. The study was to be carried out "with mutual respect for each country's choices and decisions * * * without jeopardizing their respective fuel cycle policies * * * and contracts for the peaceful use of nuclear energy."

The organizing conference successfully agreed to roles for eight working groups, and gave the groups considerable autonomy. A technical coordinating committee was set up to compare work programs and discuss gaps or overlaps in the work.

I would like to ask Dr. Rathjens if he would summarize for you how we see INFCE's results.

Mr. McCormack. Dr. Rathjens, welcome. Please go ahead.

Dr. RATHJENS. Rather than going through the issues sequentially, as they were dealt with by the eight INFCE working groups, I would prefer to give you my overall impressions of INFCE, and then comment on some of the key problems, as I see them, where there is an interface between questions of nuclear power and nuclear proliferation, emphasizing the relevance of INFCE to the resolution of those problems.

Let me say first that any judgment about INFCE will depend strongly on expectations and preconceptions. Mine were, I believe, low compared to those of some others who played a role in the formulation of U.S. nonproliferation policy, the writing of the Nuclear Nonproliferation Act, and the organization of INFCE. I did not have high expectations that INFCE would come up with technical fixes that would permit the reprocessing of spent fuel without the proliferation risks inherent in the separation of weapons-usable materials.

I questioned whether other countries would approve of some of the requirements that our Nuclear Nonproliferation Act imposes as a condition for nuclear commerce. And I was extremely skeptical that the countries with major commitments to reprocessing and breeder technology would follow our lead in foreswearing the former and in going slowly with the latter.

Having started with these kinds of expectations, my overall reaction to INFCE is positive. It accomplished more than I believed likely 2 years ago. Consensus was achieved on some important points. With a single exception, I do not believe, however, that achievement of consensus alone will have provided a basis for the resolution of outstanding issues in international nuclear energy policy.

This is, in part, because we failed to reach agreement on a number of questions, and where this was true, the divergent views are reflected in the reports. But equally important, there were a number of questions INFCE did not treat adequately or in some cases at all. For the most part, this was inevitable, considering its mandate. In the next few minutes I will illustrate these points.

The really key issues from an American perspective were those relating to the processing of spent fuel and the development of a plutonium economy. There are a number of questions relating to these. Let me start by considering the three principal motivations:

First, an interest in recycling plutonium in thermal reactors;

Second, the desire to develop and deploy breeder reactors; and

Third, the belief that waste disposal could be more safely or economically accomplished if plutonium was removed from spent fuel.

Let me turn to these in that order.

First, thermal recycle: The fourth INFCE working group had responsibility for consideration of the recycle of plutonium in thermal reactors. A major emphasis was on the economics. A number of nations contributed to that analysis, and consensus was reached that the economic advantage, if any, of recycle would be small.

This was an important finding, consistent with our views. The fact that others agreed on this point does not, however, mean that all concur that the recycling of plutonium in thermal reactors should be avoided or delayed.

Some others continue to believe that this is an important option to be kept open because of possible economic advantage should uranium prices rise substantially or because they believe it desirable to dispose of the plutonium that might be separated if reprocessing is undertaken for other reasons, for example, because of waste disposal arguments.

There is also a belief that whatever the economics, reprocessing and thermal recycle may be important because of uncertainties about assurance of fuel supply, considering that with recycle, uranium consumption can be reduced by approximately 35 percent. What the economic analysis of working group 4 did was to remove from contention one important issue relating to thermal recycle, that of possible economic advantage.

It also emphasized the importance of taking account of safeguarding problems during design of reprocessing and fuel fabrication plants, that in reprocessing there will be economies of scale, and that there may be advantage in multinational facilities. I do not believe we could reasonably have expected more.

Now, let me turn to the breeder. Most of the analysis relating to breeders was carried out in the fifth working group, a group that was dominated by breeder enthusiasts. My own impression is that the report of that group is somewhat unbalanced in that it highlights the advantages and potentiality of the breeder without giving due weight to difficulties and problems that must be dealt with if breeders are to be widely deployed.

Again, economic analysis was important, and I do not believe that we can quarrel with the findings of the group in that respect. It points out that breeders will be costly, and this will be particularly true for nations that wish to achieve a substantial degree of independence with respect to the technology. The point is made that the breeder, therefore, is not likely to be attractive for nations not having a substantial technical infrastructure, nor for those with thin electric grids.

Even more than in the case of thermal recycle, economic analysis may not, however, be determinative in decisions of nations to go ahead with this technology. It will have some relevance, of course, to the question of commercialization, but less to the question of R. & D.

A number of nations continue to feel that it is important to develop the breeder so that the option for commercialization and deployment will be available, some believing that this may be important as early as the 1990's. The interest in maintaining the option is consistent with our own policy, of course, but we do not share the emphasis in INFCE on the possibility of early deployment of breeders in large numbers.

The difference is in large measure ascribable to differing views about the likelihood of assured access to adequate amounts of uranium to maintain and develop generating capacity based on thermal reactors.

It has been our view that we would have assured access to sufficient amounts of uranium and enrichment service so that deployment of breeder reactors on a commercial scale could be deferred until well into the next century, and further, that one would reach similar conclusions for the world as a whole if one looked at demand for nuclear power and availability of uranium and enrichment service on an aggregated basis.

The INFCE projections that were made for the growth of the nuclear industry seem excessively optimistic from the perspective of 1980. We argued that they should be revised downward, taking account of developments that occurred during the period 1978 to 1979, but without success. We were rather more successful in getting agreement on what we believe to be acceptable projections for the availability of enrichment service and producibility of uranium.

When the INFCE supply-demand projections are looked at together, the findings are inconclusive with respect to the urgency of breeder deployment. If one assumes that the demand for nuclear power will be at the high end of the INFCE estimates, the case can be made that there is some urgency in getting on with the breeder.

On the other hand, if one uses the low end of the range for demand, and even that now seems high in my view, it can be reasonably argued that there need be no great urgency in getting on with breeder deployment. It follows from this that even development and demonstration could be somewhat delayed without great risk.

Having said this, it must be conceded that all of the supply-demand analysis in INFCE, including the work relating to reducing uranium consumption in the thermal reactors through technological improvements, may not be determinative with regard to national decisions about whether to proceed with the breeder, and at what pace. This is because some are skeptical of analysis based on supply and demand for the world as a whole, or even for the world outside the Communist Bloc, which was the basis for INFCE's analysis.

As in the case of thermal recycle, INFCE helped narrow the area for debate. We need no longer argue much about economics. Moreover, if there is acceptance that the lower INFCE projections for the growth of nuclear power are more realistic than high ones, there could be a further narrowing. We could forgo arguing about whether world uranium resources could supply thermal reactors for the rest of the century.

But accepting the first and assuming the latter of these conclusions would not dissuade some others from going ahead with breeder development and demonstration and necessarily, therefore, with reprocessing. There are the residual problems of access to uranium and enrichment service.

This emphasizes the importance of consensus on mechanisms, in which nations could have confidence, for assuring access to uranium. The most important argument for moving ahead quickly with the breeder could be dealt with if it were possible to reach agreement on supply arrangements with which nations could be confident. Working group 3 of INFCE looked at this complex problem and made some progress. The actual testing will come in bilateral supply experience in the future.

We have here a fundamental dilemma. Our policy and our law require that we condition our supply of fuel and technology on others accepting U.S. approval rights over the use of U.S. origin materials. Yet, the imposition by us of conditions on supply necessarily reduces the confidence of others that they will have access to fuel and technology.

We turn now to waste disposal. It has been a U.S. position when INFCE began that there would be little, if any, economic or environmental advantage in separating plutonium from spent fuel as a precursor to disposal of wastes. Other countries, most particularly the

Federal Republic of Germany, had however based their whole nuclear policy on the contention that the separation of plutonium was not only a desirable, but a necessary, precondition to waste disposal.

The conclusions of working group 7 were generally consistent with the American view: the technical feasibility of disposal of unreprocessed spent fuel is accepted.

Again, the area of debate is somewhat narrowed as a result of INFCE, but without there being an acceptance of the view that spent fuel should be disposed of irretrievably. No nation with a major program is yet prepared to throw away the energy values inherent in the plutonium in spent fuel.

Moreover, notwithstanding the work of INFCE's working group 6, there are no solutions to spent fuel storage problems in sight. The major problems are not technical, but ones of political acceptance, which INFCE could not reasonably address.

In summary, in considering all of the issues relating to a plutonium economy, we find several conclusions in INFCE that are supportive of U.S. policy, but INFCE certainly does not provide a complete basis for its general acceptance.

I mentioned earlier that in one area INFCE's findings are probably sufficient alone for a consensus on policy. There was acceptance of the view that for the most part the use of highly enriched uranium in research reactors could be dispensed with.

While there are many other questions about INFCE which you may want to raise, I should like to take the remaining minute or so to focus on one of the specific questions posed in your letter, that of improved nuclear power technologies and where INFCE indicates the priorities might be.

Beginning at the front end of the fuel cycle, INFCE looked at different enrichment technologies. It was impossible to get consensus on a ranking of alternatives on nonproliferation or other grounds. There was a consensus that, as in the case of reprocessing, large multinational endeavors would have advantage over small, dispersed, national facilities from both an economic and a nonproliferation perspective.

Moving on, there was strong support for light and heavy water thermal reactors and for the liquid metal fast breeder. There was little real support for other advanced reactors.

It proved to be impossible to get general agreement on the relative proliferation risk inherent in different reactors or different total fuel cycles, although the risks in sensitive stages—enrichment and reprocessing—were clearly identified. Safety and environmental concerns were not extensively treated.

The United States presented analysis of the feasibility and desirability of technical improvements that could reduce uranium consumption in thermal reactors. Most other participants accepted the near-term 15 percent improvement, but felt that we were overly optimistic with regard to further increases.

There was consensus that some modifications in reprocessing and fuel fabrication, such as co-processing and spiking, would reduce risk of weapon-usable materials being acquired through theft. INFCE concluded, however, that neither these options nor such possibilities as fuel cycles based on thorium would offer significantly increased resistance to weapons proliferation by nations. In other words, it did not come up with promising technical fixes to the reprocessing problem.

Now, I think Ambassador Smith would like to pick up again on where we go from here.

Mr. McCormack. Thank you, Dr. Rathjens.

Ambassador Smith, do you care to continue?

Ambassador Smith. Mr. Chairman, in assessing INFCE and the relation to INFCE findings to current U.S. policies, it is important to reiterate its basic nature. It was to be a factual and analytic study, not a negotiation. No country was committed to any result.

It was recognized that INFCE could not resolve outstanding issues, nor could it per se result in deferral or changes of programs. In particular, INFCE was not likely to result in other nations' deferral of fuel cycle developments, nor was it expected to modify U.S. policies of concern to other countries.

I think all participating countries would now agree that INFCE has narrowed differences, in particular, regarding such matters as terminal waste disposal, the main features of proliferation risk assessments, and the availability of uranium resources.

Differences that remain are likely now to be expressed in terms of judgment rather than fact. While different nations will emphasize different parts of the INFCE reports, the different national views should generally be consistent with INFCE common ground and more often than before should recognize other viewpoints. This will be true of the United States as well as others.

We have gained from INFCE a greater appreciation of others' concerns and perspectives. This is reflected in our statement at the final INFCE Plenary last February, and Mr. Chairman, I would like your authority to insert in the record the statement I made in Vienna last February.

Mr. McCormack. Without objection, it will be inserted in the record at this point.

[The above-referred information to be furnished the committee follows:]

STATEMENT OF

AMBASSADOR AT LARGE HONORABLE GERARD SMITH
UNITED STATES REPRESENTATIVE TO THE
INTERNATIONAL NUCLEAR FUEL CYCLE EVALUATION

AT THE FINAL PLENARY CONFERENCE
FEBRUARY 25, 1980

Mr. Chairman,

I am pleased to represent the United States at this concluding plenary conference of the International Nuclear Fuel Cycle Evaluation. President Carter has asked me to deliver the following message:

> The International Nuclear Fuel Cycle Evaluation, now completed, was a valuable forum in which to examine a number of the economic and technical issues, as well as the question of nonproliferation, as they relate to the development and continued use of nuclear energy. The Evaluation's final reports contribute greatly to increased understanding among members of the international community.
>
> I would like to express appreciation to the representatives of the participating governments and international organizations for their hard work over the past two years. The United States will carefully review the Evaluation's results and take them into account in implementing its national and international policies with regard to the development and expansion of nuclear energy.

We all share the conviction that nuclear power is needed to conserve valuable nonrenewable resources and, in many countries, to reduce intolerable dependencies on imported fossil fuels. I believe we all seek to assure that nuclear power will be generated only under conditions serving to minimize risks of nuclear proliferation.

For over two years, since the INFCE Organizing Conference in Washington, representatives of the countries and organizations gathered here have labored jointly and diligently in an unprecedented undertaking in international cooperation. We have pooled our analytical talents to examine the various fuel cycles, their risks, and the ways in which such risks might be minimized through institutional and technological measures. We have explored ways in which nuclear supply assurances can be improved, and have given attention to the special needs of developing nations.

We were not asked to negotiate "solutions" but rather to offer governments our collective analyses of the implications of different approaches.

The United States believes that INFCE has been a success. I would hope that all participants will join in accepting the working group reports with appreciation and in forwarding them for study by governments, the IAEA, and other appropriate international organizations. I propose that our special thanks be expressed to the IAEA for its essential help and to Professor Abram Chayes, whose leadership as Chairman of the Technical Coordinating Committee played a crucial role in assuring the successful and timely completion of this Evaluation.

When I say that we believe that INFCE has been a "success," I do not wish to imply that the United States or any other nation, agrees with every statement in the reports. The participants in INFCE have worked as experts seeking consensus. Accordingly, the reports reflect a wide range of perspectives, judgments, and viewpoints. These include the views of developing countries eager to assure themselves of access to the benefits of nuclear power; the perspectives of both exporters and importers of uranium, enrichment services, and reactors; the views of those now engaged in developing breeder options; and the views of nations, like mine, which believe they can prudently defer moves implying a commitment to "a plutonium economy." All interested nations have had their views considered and reflected in the reports.

On most matters of substance, the members of the working groups and of the Technical Coordinating Committee were able to reach agreement on a single view. On some matters, however, such convergence was not achieved and the residual differences are expressed in the reports. Without justifying or finding fault with the nuclear power policies of any nation or group of nations, the process has produced a common factual background and findings which should inform our thinking, facilitate new international understandings at the political level, and help achieve a more orderly international community, as we seek to realize the benefits of nuclear power under conditions consistent with nonproliferation policies.

With the firm belief that INFCE has been constructive, I should like to refer to a few matters that strike us as particularly useful and also to mention briefly a few areas where we believe some cautions are warranted.

I start with a word about the process of INFCE itself. Before its start there was understandably a very wide range of perspectives, and insufficient mutual communication. The international nuclear community was in a state of some disarray. Tensions were developing between suppliers and consumers, and there were widespread misunderstandings of each other's problems and concerns.

INFCE has helped to remedy that situation. We now better understand each other's objectives, needs, and interests. All of us have a better appreciation of global nuclear energy needs and resources, worldwide concerns about nuclear proliferation, and the technical and institutional problems and possibilities that lie before us. We hope that the IAEA will review our findings with the participation of all interested states, so as to identify those INFCE matters that merit follow-on IAEA actions. And, we should strive to preserve the spirit, tone and momentum of this effort.

The clear recognition in INFCE of dual objectives is important. The continued value that nuclear power has and will have for many of our economies is emphasized. There is also broad agreement that there are proliferation risks associated with nuclear power as well as measures that can and should be taken to make such risks more tolerable and manageable. We all recognize that proliferation is basically a political matter, and that if a nation elects to develop nuclear explosives, it can do so without misusing civilian nuclear power facilities. However, INFCE points out that such facilities can be misused and that for this reason it is important to plan future fuel cycles with careful attention to proliferation risks. The United States recognizes that there are such risks in every fuel cycle. INFCE has not identified any technical solution that will eliminate such risks; but it has identified several major positive factors useful in future planning.

We accept the judgment of INFCE that it is not appropriate to make broad generalizations about the comparative proliferation risks of different fuel cycles. For example, we appreciate the fact that comparison of the proliferation resistance of the once-through light water reactor cycle with alternatives must also include consideration of the location and types of uranium enrichment facilities and how they are to be safeguarded.

I believe we have all come to share the assessment that there are substantial risks associated with weapons-usable materials and the technologies that can produce them. Our collective acceptance of this premise should help steer the future of nuclear power in safer directions. New protective measures, including but not limited to improved safeguards, will be required to cope with fuel cycles involving ready access to significant amounts of weapons-usable materials.

We are now more conscious of the long-range implications of near-term actions, and we already are moving to constrain the use of weapons-grade materials in reactors when such use is not essential. The recent move to convert research reactors to use lower enrichment fuel is an example.

A single fuel cycle will not satisfy all nations' needs. Clearly, different national situations require different choices. For example, the need for and timing of breeder development will vary among countries depending on their technical infrastructure, electric grid size, confidence in access to uranium resources, and other factors. Especially important is the relationship between demand for power and the availability and price of uranium.

On the resource side, I believe that INFCE did a good job in evaluation of the factors bearing on prospective availability of natural uranium.

On the demand side,there will be a need for periodic revision of the estimates developed in INFCE. For example, since these estimates were prepared over two years ago there have been large reductions in reactor orders and lengthy delays in construction schedules. This has resulted for the United States, which makes a major contribution to total demand, in a reduction in projections for 1995 nuclear capacity of about 30 percent. Since the urgency for construction of additional fuel cycle facilities and the introduction of new technologies depend on demand-supply relationships, it is important that estimates be kept up-to-date. This underscores the need to insure that such estimates are revised periodically.

Demand-supply relationships are also important in considering the adequacy of enrichment services. We appear to be in agreement that there will be sufficient enrichment capacity through at least the mid-1990s, and new capacity can be brought on stream in sufficient time to meet demand that develops thereafter.

Reprocessing, recycling of plutonium in thermal reactors, and the need and timing for breeders were key issues in INFCE. From our perspective, several important insights emerge.

While reprocessing has been preferred by some nations as the way to deal with spent fuel, the Evaluation makes it clear that other choices are feasible. Spent fuel can be safely stored on an interim or long-term basis, and terminal disposal without reprocessing appears to be a realistic option for either economic or nonproliferation reasons. I stress this point since I believe nuclear power can only benefit if flexibility exists in the choice of approaches.

The great majority of participants shared the view that, for economic reasons, when reprocessing plants are built they, like enrichment plants, should be large in scale.

And, apart from economics, scale is an important consideration for nonproliferation reasons.

It is worth noting that all agreed that the economic advantage of plutonium recycle in light water reactors will at best be small.

INFCE working groups concluded that effective international safeguards are an essential feature of nuclear fuel cycle facilities. Stress was laid on the special need to apply effective safeguards, particularly for the sensitive fuel cycle steps involving enrichment, reprocessing, and fabrication of fuel using plutonium or highly enriched uranium. Inclusion of safeguards planning at the earliest stages of plant design is called for. The importance of giving high priority to the testing and optimization of new improved safeguards methods for sensitive fuel cycle steps was emphasized.

In that connection, I would stress the importance the United States attaches to applying effective IAEA safeguards to all civilian nuclear facilities, and to providing the IAEA with the additional funds, trained manpower, and policy support it needs to carry out its expanding safeguards responsibilities. While safeguards alone will not be sufficient to minimize proliferation risks from sensitive fuel cycle activities, we are convinced that comprehensive safeguards coverage will be necessary if nuclear power is to play its proper role in meeting global energy needs.

The participants appeared to agree that constraints that now apply to reprocessing and to separated plutonium need to be reinforced by other protective mechanisms. For example, in addressing the particular concerns associated with separated plutonium, it was recommended that as one follow-on mechanism, special attention should be given to placing excess plutonium under international oversight. The U.S. is prepared to work cooperatively for an effective international plutonium storage regime. We are also participating in the IAEA study of international arrangements for spent fuel storage.

The need and prospects for breeders understandably are given considerable attention in light of their promise and the interest that some nations have in this technology. There is no question that over the long term breeders could extend uranium resources in a dramatic way. This accounts for the heavy investments that the U.S. and other nations are making in developing the breeder and in assessing the feasibility, economic, and proliferation implications of its technology. But the breeder is not without its costs, risks, and uncertainties. Some of these are identified in the report of Working Group 5, although that report focuses much more on the positive features of the technology. We note that the report concludes that breeder development and deployment are not likely to be economically attractive to nations with modest nuclear power programs.

INFCE has provided useful insights on the special needs of developing nations. As part of the IAEA's follow-on activity, we would hope that the Agency would give special emphasis to its recommendations of particular interest to the developing world.

In examining potential proliferation risks which arise from various approaches to nuclear power, the INFCE reports dealt extensively with possible measures to reduce such risks. It was generally found that a combination of new safeguards, technical, and institutional measures, such as multinational ventures, constitute a promising approach. It will take major efforts by many nations to implement such measures by the time they are needed to deal adequately with the proliferation risks which are inherent in such sensitive facilities as reprocessing and enrichment plants. We hope such efforts will get underway promptly. We have for too long contented ourselves with merely talking about them.

Finally, INFCE has also formulated a number of important recommendations in the area of nuclear supply that should be given great weight in future governmental decisions. INFCE recognized in a variety of ways that a country pursuing a nuclear power program needs to be able to plan ahead with confidence regarding, for example, reactor fuel supply and disposition of spent fuel. We all agree that it will be crucial to preserve a high degree of confidence and stability in nuclear supply relations if nuclear power is to remain a viable energy option and if the premature spread of sensitive facilities is to be avoided. Pointed observations may be found in the working reports about the need for greater predictability in nonproliferation conditions and the prejudicial results of abrupt or unilateral changes in conditions of supply. On the other hand, the reports recognize that suppliers cannot be expected to freeze their policies or to ignore situations that might seriously aggravate efforts to prevent the spread of nuclear weapons.

The call in the reports for a greater degree of confidence and predictability in the terms of nuclear trade presents us with a major challenge. The United States believes that this goal is achievable and we intend to devote our energies and ingenuity to meeting this challenge in the immediate future.

Thank you, Mr. Chairman.

Ambassador SMITH. We believe there is considerable value in the acceptance by INFCE of the following points:

There are proliferation risks in making fuel cycle decisions;

These decisions are a matter of interest to the international community, due to a general worldwide concern over the proliferation problem; and

There are analytic approaches to resource, cost, and programmatic questions, as well as proliferation risk questions, which can be used as a common basis for rational international discussion of these issues.

INFCE concluded that there is no single answer best for all countries. All fuel cycle choices involve uncertainties. For example, the infrastructure, manpower, and technical level demanded by a breeder cycle are likely to make it unattractive for countries having small electric grids. The considerations for countries with large grids are different.

The implication of this for U.S. nuclear R. & D. and cooperation policy is that each program and cooperative arrangement should be judged individually on its merits. I do not believe that INFCE itself produced any data or analysis which substantially changed U.S. perceptions about the potential role or reasonable time scales for the various fuel cycles in the United States. For example, the uranium producibility for the United States was not specifically reviewed by others.

As noted by Dr. Rathjens, INFCE's conclusions on plutonium cycles were mixed. This means, in my view, that all countries should take into account the risks, economic costs and technical complexities of plutonium cycles, and not simply assume they are appropriate for all situations. In those situations in which there is judged to be a net benefit to plutonium use, there seems to be broad agreement that serious work should be done to improve safeguards, utilize technical approaches which minimize presence of separated plutonium, and provide international oversight for storage of plutonium.

In the proliferation risk area, as in the area of economic and technical analysis, INFCE tended to discredit oversimplifications and overgeneralizations. In particular, it was judged that an acceptable degree of proliferation resistance could be obtained with once-through systems.

But INFCE made clear that this depends very much on how enrichment is handled. Proliferation risks related to enrichment were recognized, as was the importance of minimizing the number of enrichment plants and of siting them in stable and safe locations.

INFCE underscored the importance of working towards broad international consensus. In achieving such a consensus, we face choices as to how much emphasis should be placed on achieving agreement among suppliers on export conditions, particularly on the requirement that all peaceful nuclear activities in an importing state should be subject to IAEA safeguards.

How can we balance such supplier consensus against the desirability of using open international fora, such as the IAEA, to avoid north-south confrontation over perceived discrimination?

In specific cases, how much emphasis should we place on maintaining or establishing multilateral arrangements; how much on U.S. unilateral controls?

We must continue to work bilaterally with other suppliers to strengthen the nonproliferation regime. We must also work in the IAEA to strengthen both supply and nonproliferation assurances. The IAEA Board of Governors may soon establish an advisory group on such matters. We hope it will focus efforts on near-term constructive steps following on from INFCE's working group 3 conclusions.

Some countries are prospecting for a universal, nondiscriminatory regime consisting of standard conditions of supply, as opposed to some of the bilateral controls required by the United States. An international plutonium storage system within the IAEA is being discussed by an expert group in Vienna, and some characteristics of an IPS have been identified which may result in more effective controls over plutonium.

We believe, however, that we should avoid a least common denominator on nonproliferation criteria, potential confrontation over export conditions, giving impetus through IPS to fuel cycle activities that do not make programmatic sense, and overloading the IAEA with functions it cannot perform.

Another area of multilateral attention is spent fuel storage. The United States and other interested nations are currently participating in an IAEA-sponsored study of spent fuel storage. The study is essentially an examination of how technical assistance and expertise could be provided and not an effort to add controls to the storage of spent fuel. Nonetheless, progress in this area could make a contribution to our nonproliferation efforts.

Finally, IAEA safeguards are central to the nonproliferation system. The basic questions are how best to provide technical and budgetary support; how to insure that an international agency can reliably perform a growing operational role; and what is the proper balance between potential for withdrawal from the treaty and undetected diversions and the nonproliferation contribution of safeguards, our NPT supply obligations and the necessity of broadly supported international approaches.

You have asked us, Mr. Chairman, for our views of world perceptions of proliferation risks for the 1980's, and possible future directions of U.S. policies, including prospects for international and regional arrangements, to increase international confidence in the United States as a nuclear supplier and U.S. influence in achieving nonproliferation objectives.

It is clear, as I have mentioned, that most countries now recognize proliferation risks associated with weapons-usable material and the technologies that produce it—reprocessing and enrichment. At the same time, the motivations for nuclear weapons development are driven by international and regional security considerations. There is recognition that premature spread of sensitive technologies and material should be minimized while increasing efforts to reduce incentives for weapons development.

Future U.S. policies should aim to meet both these objectives. To enhance U.S. influence in achieving nonproliferation objectives, we must, in particular, increase international confidence in the United States as a nuclear supplier. Reliability of supply is essential if other countries are to forego national enrichment and reprocessing facilities.

Measures to this end are receiving considerable attention in the concerned executive branch agencies. We will probably soon be involved in IAEA consideration of supply assurances, and are examining such possibilities as longer term fuel licensing for states with good nonproliferation credentials and backup fuel supply arrangements, such as a nuclear fuel bank.

We also believe that, for both nonproliferation and economic reasons, enrichment facilities should be limited in number and related to global requirements, rather than strictly national needs.

Similarly, in my judgment, new reprocessing capacity should be related to plutonium needs for breeder and advanced reactor R.D. & D., and not be driven by spent fuel management needs. While INFCE notes breeder and advanced reactor options could be attractive in countries with large electric grids and advanced nuclear programs, the economic and resource benefits of thermal recycle are marginal, at best, and are in any event outweighed by the proliferation risks inherent in the early and widespread presence of plutonium fuels.

In sum, Mr. Chairman, we are looking post-INFCE toward common approaches which will balance nuclear energy development and nonproliferation objectives. We need to increase supply assurances for those who provide nonproliferation assurances. We need to avoid premature spread of sensitive technologies and material while recognizing that different circumstances in different countries require distinctions based on need and nonproliferation credentials. The post-INFCE policy review in which we are currently engaged aims in this direction.

Thank you, Mr. Chairman.

[Additional questions and answers from Ambassador Smith follow:]

QUESTIONS FOR
AMBASSADOR SMITH AND DR. RATHJENS
following
INFCE HEARINGS
June 4, 1980

1. In President Carter's address to the plenary session of INFCE, he stated "I hope that all the nations represented here and others will assess alternatives to turning to this source of power..." To some extent this Administration's policies have made this statement self-fulfilling. Is there anything, however, in the final report of INFCE which would give a nation reason to deny itself nuclear energy?

2. Was INFCE a success??

   a. Was INFCE a success and if so why - please be specific.

   b. Has any specific way to prevent a country from proliferating been developed by INFCE?

   c. Has U.S. influence abroad increased or decreased as a result of INFCE?

   d. Is it correct that the Russian market for enriched uranium has expanded in the free world during the two year hiatus caused by INFCE? Russian influence must certainly grow with its market. Has this been considered in assessing the impact of U. S. policy?

3. It has been said that U.S. non-proliferation policy is heavy on the stick and light on the carrot. In the post-INFCE period, what positive inducements can the U.S. make which might further our common goal of preventing proliferation? Recognizing that arguments cut both ways, what positive effects could occur from the operation of a multinational reprocessing center at Barnwell?

4. It has been stated by some that in INFCE the U.S. placed the greatest weight on (perceived) non-proliferation goals whereas most of the other nations made energy security their first priority. If this is a valid assessment, shouldn't the issue of energy security be given more weight by us, not only in considering the nuclear ambitions of other nations but also in relationship to our own nuclear programs, particularly in the post-2000 period?

5. It is obvious that our R&D programs were slowed down by the Administration during the INFCE period.

   It is also obvious, from what the other countries participating in INFCE have said they regard as the most significant results of that voluminous effort, the slow down or self-denial by the U.S., makes no sense to them - except the Soviet Union.

Even the British have said that they and we have a serious responsibility to other nations critically dependent on imported oil and uranium to bring the breeder on line in our respective countries as quickly as possible.

a. Do you still disagree with the British?

b. Won't the U.S. be encouraging others to move into the sensitive operations on their own by continuing to refuse to demonstrate we are willing to develop those support facilities?

c. To what degree do you feel that the rest of the world would feel that a demonstration of U. S. willingness to develop such support facilities would provide an atmosphere of stability and balance to the currently volatile situation?

d. In light of the aggressive nuclear development programs of many foreign nations and the loss of U.S. influence abroad, what emphasis should be placed on U.S. nuclear R&D programs in sensitive areas such as reprocessing.

6. The ability of the United States nuclear industry to compete in international nuclear commerce has been heavily affected by the 1978 Nuclear Non-Proliferation Act and recent competition from other nuclear supplier countries. Isn't the continuing strength of the U.S. nuclear export industry an important factor in the United States' ability to gain its nonproliferation goals and how does the Administration plan to address this problem now that INFCE is completed?

7. What is the view of the Administration concerning the effect of INFCE on the 1978 Nuclear Non-Proliferation Act? Does it believe that the Act's attempted embodiment of a unilateral U.S. control mechanism over nuclear exports and other aspects of international nuclear commerce are still viable? Should modifications in the Act be made?

8. The decision-making process on issues such as these has always been something of a puzzlement. To what extent, for instance, is your office consulted on domestic actions which have international implications, as, for example, the decision to defer the Portsmouth add-on? I was somewhat surprised to read in the trade press that CEQ and the NSC have contracted with outside groups to do several non-proliferation studies. How do agencies like CEQ become involved in the process? What has been their effect?

9. There seems to be a great deal of momentum within the international community toward an international plutonium storage regime. Why has the Administration changed its attitude toward IPS? Is this in any way connected with the results of INFCE?

10. Are you optimistic about the prospect of reaching new agreements with other countries? Why should a country which already has an agreement with the United States be willing to renegotiate simply because we have changed our policies?

ANSWERS OF AMBASSADOR GERARD SMITH AND DR. GEORGE RATHJENS TO QUESTIONS FOLLOWING INFCE HEARINGS, JUNE 8, 1980

1. INFCE's mandate and areas of analysis did not include a comparative assessment of nuclear power with other energy alternatives. Therefore, the INFCE reports do not explicitly address the question of decisions between nuclear power and other alternatives. They do convey the importance attached by many advanced countries to nuclear power, and the interest of some developing countries in that option. Many others are not in a position to consider nuclear power options in the near future. In that connection, the INFCE reports described some of infrastructure requirements and difficulties faced by developing countries in implementing nuclear power programs.

2a. As discussed in the annual report to Congress earlier this year, INFCE was a success in terms of broad attendance, serious analytic effort, and expanded commonality of view in several areas. These areas included IAEA safeguards requirements, uranium projections, technical measures such as reduced enrichment for research reactors, and waste management considerations. From a US non-proliferation standpoint, INFCE conclusions included many points of importance to us, and some that did not reflect our positions. On balance, we believe it is fair to characterize INFCE as a success.

2b. INFCE conclusions are consistent with our view that no "technical fix? is adequate to proliferation. INFCE accepted the view that motivations are a key factor in proliferation, but also made clear the important contribution of some potential technical choices or measures. Key examples are design of facilities to facilitate safeguards, and avoidance of widespread presence of nuclear weapons-useable material, either highly enriched uranium or separated plutonium. Such measures can be critical in reducing risks and perceived risks in areas of tension or instability.

2c. I believe that INFCE had a healthy effect on perceptions of the US and on our influence in the nuclear area. I presented an opportunity for us to reduce misunderstandings of US non-proliferation policy. This is not to say that the US viewpoint always prevailed in INFCE.

2d. During the last few years there have been changes in commitments to enrichment services, including increases in the Soviet share. Changes in trade patterns and the reasons for them are of course taken into account in assessing our policy. I should note that INFCE did not cause the hiatus in which these changes occurred. No country was obliged by INFCE to defer any programs or decisions. The hiatus has been, rather, primarily a product of sharply reduced electricity growth rates, and economic and other perceived uncertainties with nuclear power.

The importance of the US being a major enrichment supplier and of importing countries having confidence in US supply is a key element in US policy. Much of our effort within the Executive Branch is to solidify the US position as an attractive and reliable supplier.

3. As one element of non-proliferation policy, we will maintain and expand the positive incentives in peaceful nuclear cooperation, for example by supplying enrichment services on favorable economic terms, longer term licensing of exports, and offering technical assistance in such areas as reactor safety, waste management, research reactors, manpower training, and spent fuel storage.

We have over the last several years assessed both potential positive and negative effects of operation of a multinational reprocessing center at Barnwell. Such potential positive effects as removing pressure toward reprocessing elsewhere, demonstrating improved safeguards, and demonstrating multinational approaches have been outweighed by substantial potential negative effects, such as unnecessary separation of plutonium with inevitable pressure for return to other countries, dilution of IAEA resources when other "test beds" are already under safeguards, the potential for misapplication of the reprocessing training conveyed to other countries, and the major federal funding which would be required to bring Barnwell into operation.

4. There was, in INFCE, a spectrum of views: the US and many other countries in ascribing importance to non-proliferation considerations; many other countries heavily emphasized the importance to them of energy security. These are not mutually exclusive goals. For example, we are putting major effort into increasing confidence in nuclear supply and improving the energy security context for nuclear power. On questions related to US energy security, I defer to the Department of Energy. I believe, however, that the US approach of pursuing nuclear power and other elements of our energy mix in parallel is appropriate. With regard to nuclear power in the post-2000 period, DOE's analysis of breeder introduction dates is based on US indigenous uranium only and thus, I believe, takes a properly cautious approach to US energy security.

5. For a discussion of US R&D programs, the Department of Energy would be most appropriate. Some US R&D, such as improving LWR performance, has been accelerated. In any case, I believe it is important not to oversimplify the views of other countries. I know of no governmental position of any other country, based on INFCE or otherwise, which states that the US breeder R&D program does not make sense in our circumstances.

There undoubtedly are people in breeder programs in other countries who have stated or implied that they believe the US should aim for earlier commercialization. There are also many in other countries who are entirely anti-nuclear. Neither are expressing official foreign governmental views of our program. The British view you mention is, to my knowledge, the personal view of one UK citizen. the UK has a breeder R&D program but has taken no decision on commercialization in their own country.

a. In the context just described, there is no issue of "disagreeing" with the British..

b. and c. I believe decisions on the US nuclear program will be taken primarily in the context of meeting our own energy needs, and will not have a major impact on decisions by other countries to defer fuel cycle programs through any US offer of services.

d. I believe the emphasis of US R&D programs should be placed primarily on areas of need or potential for US energy strategy, with consideration given to potential proliferation-resistance features. While I do not see this as indicating a high priority for R&D on reprocessing, I understand some reprocessing R&D is included in the US breeder R&D program. This would seem to be appropriate.

6. It is certainly true that the combination of other sources of supply, consumers' desires for diversification of supply, and tendency toward indigenous programs have reduced the degree of worldwide dependence on US supply. I completely agree that US cooperative relationships with other countries are an important factor in our ability to gain non-proliferation goals. Some of the measures we are taking, including long-term licensing and expanded enrichment capacity, are mentioned above. In addition, we are working on streamlining and simplifying export procedures. The GAO review of the NNPA, due next March, will also be relevant to our review of this subject.

7. We believe that the Act has substantial flexibility built into it, and that it forms a generally acceptable basis for our international cooperation. Our degree of success in implementing such cooperation will be dependent, in part, on the degree of common view and purpose between the Executive Branch and the Congress. With regard to amendment of the NNPA, we will want to continually assess possible future needs and stay in contact with the Congress concerning any amendments that can enhance our nuclear export and non-proliferation programs.

8. As the President's Special Representative for Non-Proliferation Matters, I am generally consulted on matters related to our non-proliferation efforts. I do not believe it is appropriate for me to comment on the roles of other Executive Branch departments and offices.

9. There is considerable interest within the international community in an International Plutonium Storage regime, but a single broadly accepted definition of such a regime has not been worked out and may take some time. Our own views had had the benefit of more inputs from other countries (in part through INFCE) and more analysis on our own part. Our view has been and remains that if an IPS regime were properly defined, widely adhered to, and not taken as a justification for separation of unneeded plutonium, it would make a positive contribution to non-proliferation. We are continuing to participate actively and constructively in international consideration of an IPS.

10. We have successfully renegotiated or amended five agreements for cooperation (those with Australia, Canada, the IAEA, Indonesia, and Norway) other countries, and have completed negotiations on new agreements with three other countries (Colombia, Morocco and Peru). In the past, agreements have been periodically updated at the suggestion of one party or the other. While a few countries have expressed little or no interest in renegotiating our existing agreements, we have been engaged in active negotiations with many others. Some have strongly supported our general ovjectives in this effort, (although they may question some specific US positions), and others see this as an opportunity to strengthen the basis for cooperation with the US or to solve issues they may leave with us. With appropriate give-and-take, we expect our renegotiation program to move forward.

Mr. McCormack. Thank you for an excellent statement.

I have been writing questions almost as rapidly as you have been reading your statement, but before we start, I should like to ask Congressman Wydler, the ranking minority member of the committee, to make his opening statement at this time.

Mr. Wydler. Mr. Chairman, I apologize to you and to the other members of the subcommittee for being late.

This topic today I find of deep concern to myself. Today's topic on the question of nuclear development in the wake of the international nuclear fuel cycle evaluation cannot be discussed, in my opinion, separately from two other major issues. The entire question of the administration's approach to implementation of its nonproliferation policy, and the interpretation of the Nuclear Nonproliferation Act passed by the Congress must be considered in great detail.

I have discussed the question of international nuclear development with officials of more than 15 nations around the world, and have concluded that the administration's policy of denial of nuclear materials and technology has been a completely counterproductive approach to achieving our nonproliferation goals.

As I wrote the President on April 23, this policy has not resulted in keeping critical nuclear technology from other nations, but rather, in simply losing billions of dollars of business and, consequently, crippling the U.S. nuclear industry. I told him, and I quote:

> It seems to me that even a policy deliberately aimed at dissipating our U.S. civilian nuclear capability could not have been more successful than this simplistic policy of denial.

On my recent trip to South America, I discovered that in the case of Brazil and Argentina, we see a microcosm of the failure and the counterproductivity of the administration's nuclear nonproliferation policy. There are two extreme results of our blundering on nuclear matters in South America. We have succeeded in providing the Soviet Union an entry into that part of the world for their own technology and related policy influence.

We have also succeeded in driving the Brazilians and Argentinians to a cooperative agreement in nuclear energy technology development utilizing the same materials and technology that we sought separately to deny them.

In my note to the President, I called for, and I quote:

> A much more flexible approach to nonproliferation based on bilateral agreements that recognize differences between traditionally friendly nations and those who are our enemies or at least are seen as unreliable.

I do not think it takes a skilled diplomat to see the differences between the Pakistanis and the Argentinians on nuclear matters. Certainly, the President would have received much more support from these nations in his attempt to apply sanctions to the Soviet Union and Iran if he had adopted a more realistic and sensible approach to South America.

We have reached ultimately a simple dead end street because of an approach of military and nuclear technology denial coupled with a compulsion to lecture other nations on human rights because they do not choose to run their countries in our graven image.

Now the President has shown signs of taking a more practical approach both to the Argentinian relationship and the request of India for nuclear fuel. We see that he is attacked by the antinuclear and human rights zealots. His own State Department official threatens to resign simply because the President has decided that it makes much more sense to treat the Argentinians on the basis of mutual respect and attempt to arrive at positive solutions to a diplomatic impasse.

Frankly, and personally, I wish he would.

The Nuclear Regulatory Commission's recommendations on the question of providing fuel to India based on an inflexible and absurd interpretation of the Nuclear Nonproliferation Act is further evidence of the fact that the President is having serious problems with top officials in his own administration.

I am sorry I was not here to welcome Congressman Corcoran, who distinguished himself as the Commerce Committee manager for the NRC authorization bill, and I want to state that I enjoyed working with him to see that Congress took a reasonable position on nuclear safety.

In the case of you, Ambassador Smith, I believe you are a very good man and are making the best of a very difficult job. I may say that in my visit to Argentina I heard nothing but praise from the people in Argentina concerning yourself.

I do not know if I have helped you or hurt you by saying that, but I want you to know that you were well received down there, and you did a lot to mend a lot of diplomatic fences for our country, and you should be commended for that.

Unfortunately, I believe you have been saddled with a 1950 philosophical approach to a 1980 problem, and you have my best wishes and my prayers in carrying out what I consider to be a very unrealistic assignment.

Mr. Chairman, I look forward to hearing the questions, and I look forward to reviewing the statements that the two very distinguished gentleman have made to our subcommittee today.

Mr. McCormack. Thank you, Mr. Wydler.

We will now have a question session, which I am going to try to limit. We are going to have difficulty finishing this hearing today under any circumstances, and although I could probably ask questions for an hour, I shall limit myself to a couple of brief ones and will give everyone an equal chance.

Ambassador Smith, you and Dr. Rathjens have commented that you believe INFCE was a success, and yet, during the time that it was going on, we have seen an acceleration of a go-it-alone philosophy developing in other countries with respect to reprocessing and enrichment. And, indeed, if there is any validity at all to any of the arguments associated with calling for INFCE in the first place, it would seem that INFCE itself was self-defeating in that it spent a lot of time begging the questions rather than trying to solve them.

I wonder if you would care to comment on that.

Ambassador Smith. I think that the cases of go-it-alone in reprocessing that I know of largely ended with INFCE. If you are talking about the effort in Pakistan, that started well before INFCE.

In Argentina, as you know, they have been doing work on a pilot plant basis long before INFCE.

I think that on enrichment, the South African Government has been operating an enrichment plant long before INFCE. The Japanese started their enrichment work long before INFCE.

So I do not think you can blame INFCE for those cases. I asked George Rathjens before if he knew of any case where there really has been a serious startup of a reprocessing effort since INFCE. Perhaps I have overlooked a case, but the reason I called INFCE a success, or one of the reasons, was, as you probably recall, it started in under very poor circumstances.

It was almost made a mockery of by certain of our friends from abroad, and they entered into it with high cynicism. My understanding in talking to the participants in this is that it almost universally is recognized as a very serious effort; and the quality of the work was excellent, and the understanding of the issues has been substantially advanced because of INFCE.

Mr. McCormack. I think that is a tribute to you personally, Ambassador Smith.

Ambassador Smith. I must say that, to the extent that INFCE was a technical exercise, although I had responsibility for it, Dr. Rathjens is the man who did the technical input for it.

Mr. McCormack. If you had gone in, let us say, and started with the position or objectives on nuclear energy and policies on nuclear energy growth and uranium availability that were provided in some detail to the administration by the old Energy Research and Development Administration before April 1977, and gone into an INFCE-type meeting with such a projection, which would not have been an official antibreeder position by the administration, don't you think it would have accomplished a great deal more? Don't you think it could have addressed this problem solving instead of just simply talking about areas of agreement, instead of areas of difference?

Ambassador Smith. I am hard put to answer that. I was not here when those estimates were submitted. I do not really know what they are.

Mr. McCormack. Fundamentally, the position at that time that was presented to President Carter about 2 days before he made his antibreeder, antireprocessing policy statement was for substantially lower projections for the availability of uranium, realistic availability, and for a higher growth rate for the need for nuclear fuel before the end of the century. Thus, it would not have been an antireprocessing posture, nor an antibreeder posture.

Do you believe that if you had gone in there armed with an American policy that was not greeted with such hostility by the other members of INFCE that you could have worked toward solving problems, such as developing agreements for implementing some of the obviously concluded points, such as the fact that multinational fuel centers are better than the individual nations going their own way?

Ambassador Smith. I think if it had not been for the change in the American policy, INFCE would never had taken place.

Mr. McCormack. Are you now complaining or bragging, Mr. Smith?

Ambassador Smith. Somewhere in between. [Laughter.]

Mr. McCormack. Having been through all of this, having listened to the projections of the other nations, what do you think our policy should be today?

This committee is obviously committed to trying to move forward with our nuclear programs, and we have had repeated hearings and debates and testimony on the breeder program. Dr. Deutch was here before this committee just a few months ago, presenting the formal position of the administration that we are not against the breeder, but we just do not believe we should have it this soon, and therefore, we should not commit ourselves to a demonstration plant until 1985. We are not going to need it until 2025, and therefore, we should start in 1985, rather than 1981.

Do you believe that is a wise position to take now? Do you think we should be following a position now that we should not be developing the ability to make intelligent choices with respect to the breeder?

Do you believe we should be ignoring the possibility of establishing multinational fuel centers, using Barnwell as a model, in view of the fact that the administration is not for funding Barnwell at all this year?

Ambassador SMITH. Mr. Chairman, I am a simple lawyer who is charged with foreign policy responsibility, and I hesitate to get into the field of judgments about timing of breeder development. I think you really ought to address that question to the experts that I understand you are going to have here on breeders.

Mr. MCCORMACK. Do you believe that—I guess I was going to ask the same question another way—that is, do you believe we could have accomplished any more if we had not gone in emphasizing the delay of breeders and the hazards of plutonium but rather, emphasizing the potential use of breeders and the use of plutonium?

Ambassador SMITH. I think that, to the extent that a main thrust of INFCE was to look at the nonproliferation question and to get a better awareness around the world, it seems to me that our approach was quite correct, and that was the takeoff point for the INFCE nonproliferation examination.

If we had started in and said, well, there is no real problem with breeders and production of plutonium and thermal recycle, there would not have been much to study.

Mr. MCCORMACK. I did not say that. That is not the administration's position either. Their position is we should indefinitely delay these things, and they think everybody else should, too.

Ambassador SMITH. Perhaps I am missing the thrust of your question.

Mr. MCCORMACK. Would you like to try that?

Dr. RATHJENS. It is clear we disagree on the matter of timing. You asked earlier if we would have been better off if we had gone into INFCE with the earlier projections about uranium availability. All of these things relate.

I think we went into INFCE with realistic projections, taking account of the sad state of the nuclear enterprise in this country. I am not happy about the projections for growth, but I think if we look at those things realistically, the fact is that we probably will have enough uranium and certainly enough enrichment service so that we are not going to be in the kind of tight situation on supply and demand that characterizes some other countries, for example, Japan, France, and what might be the right schedule for them on breeder deployment is probably not necessarily the right one for us, and we can afford more delay.

Mr. McCormack. Did you say the "sad state" of the nuclear industry?

Dr. Rathjens. I think it is sad.

Mr. McCormack. Well, whose fault is that but the administration's?

Dr. Rathjen. I would not argue that it is entirely that of the administration. We have had environmental problems, recessions, diminutions in demand for electrical energy of all kinds. I think there are a multiplicity of factors that have contributed to it.

I am just trying to state what I believe to be an accurate observation, without imputing blame to anyone.

Mr. McCormack. Mr. Wydler.

Mr. Wydler. Why don't you ask Mr. Wolpe first, and let him go ahead since he was here first?

Mr. McCormack. Mr. Wolpe.

Mr. Wolpe. Thank you, Mr. Chairman

I would like to pursue for just a moment the question of the compatibility between the INFCE projections of the United States on international supply and demand for nuclear power generating and support facilities and our own Government's projections. First of all, could you give a nutshell summary of the differences between the American projections and the INFCE projections?

Dr. Rathjens. I guess that is my baby. I will try to answer that.

The figures I keep in my mind are those for the year 2000. The numbers that we used in INFCE were 850 gigawatts on the low side and 1,200 on the high for the world, excluding the centrally planned economies—850 to 1,200.

Now, during INFCE, we felt that those numbers were high, and with each passing month, they seemed ever higher. I have not checked the latest figures that we have from our Energy Information Agency, but the last time I did look at the matter, which was a couple of months ago, it is my recollection that the U.S. high was in the same range as the INFCE low, in the range of 800 gigawatts for that period of 2000.

My own personal guess a couple of months ago was that probably a reasonable range for the year 2000 might be 450 to 700 gigawatts, very substantially lower than the numbers that were used by INFCE.

Mr. Wolpe. Almost half as much as the INFCE numbers; is that not correct?

Dr. Rathjens. I think that is right.

Mr. Wolpe. A U.S. industrial consulting firm by the name of Interdevelopment, Inc., recently released a study indicating that all of the present official projections of nuclear growth are, in fact, unrealistically high, and indeed, they ended up with their own projection of 480 gigawatts of installed nuclear capacity for the non-Communist world in the year 2000, which I think is consistent with your own projection that you were just offering.

I assume you are familiar with that Interdevelopment project report, and I wondered if you could comment on, first of all, your evaluation of the merit of that particular study; and, second, the reasons for the differences in projection which have been developed.

Dr. Rathjens. Well, I am not familiar with that particular report, but I will, nevertheless, comment if I may. I think we have seen a lot of wishful thinking here in a number of countries.

We were treated in INFCE, very frankly, to some governments arguing that they were going to have very substantial growth in nuclear power, while their representatives were wandering around the world trying to sell the excess enrichment capacity for which they contracted. It was a difficult matter.

We had situations there where we were still carrying on the bulk substantial growth in nuclear power in Iran long after the departure of the Shah and, similarly, in other countries where we know that there have been substantial diminutions in rates of growth based on either demand considerations or financial problems or environmental opposition.

Nevertheless, people continue to carry rather high figures on their books and were unwilling to reduce them.

As to why this obtained, it is probably not terribly useful to speculate about the motives.

Mr. Wolpe. I think that is a very helpful response.

Mr. Chairman, I wonder if at this point in the committee record it would be possible to insert an article from Nucleonics Weeks, which is a report of the study to which I just referred, simply a summary of the findings of that study. I think it would be helpful to have it in the record at this point.

Mr. McCormack. Without objection.

[The above-referenced information to be furnished by the committee follows:]

[From Nucleonics Week, May 22, 1980]

Official Nuclear Projections Unrealistically High, Consultants Say

A U.S. industrial consulting firm, warning that past nuclear power forecasts have led to serious miscalculations in marketing and strategic planning, has developed its own analysis which points to a sharply lower installed capacity by the end of the century than most official projections. Interdevelopment Inc. of Arlington, Va., projects 480 Gw of installed nuclear capacity in the non-Communist world in the year 2000 which compares, for example, with the figure 850 Gw as the low-case forecast of the International Nuclear Fuel Cycle Evaluation (INFCE).

"There is . . . at the present time a considerable excess capacity in almost all areas of the nuclear fuel cycle, a situation which almost certainly would have existed even without the TMI–2 incident, because of improper input data regarding demand," Interdevelopment asserts. "In the fuel cycle case, the situation is aggravated by large stockpiles of natural and enriched uranium in many countries." The firm's perception is based in large part on what it sees as debiliatating financial pressures on nuclear development, exacerbated by the Three Mile Island accident. In a recently published work entitled "World Nuclear Power and its Fuel Cycle after Three Mile Island: A Guide for Marketing and Strategic Planning," Interdevelopment foresees the following:

> Inhibited nuclear development brought about by TMI will be felt more strongly in the U.S. than elsewhere.
>
> Nuclear plant orders will be nonexistent in the U.S. and several other nations in the 1980s and continue to be weak generally. Suspected drawbacks to coal-fired generation could lead to a resurgence for nuclear development, but not in terms of installed capacity in this century.
>
> Reactor vendors and other nuclear suppliers will drop in number by the end of the decade, and weak uranium prices, unless artificially supported, will continue "for many years."

Many countries will build fuel cycle facilities, such as enrichment plants, despite international overabundance to reduce dependence on the U.S. "There is likely to be a continuing excess of U.S. enrichment capacity for many years," the report states.

Interdevelopment allows for the possibility that nuclear power could experience a resurgence because of factors such as severe fossil fuel shortages and the health and environmental effects of coal use, but the firm does not believe these developments will markedly alter the nuclear picture in this century. In its summary of its own nuclear forecast compared with others, Interdevelopment states, "Official projections of nuclear power capacity, which are generally made using computer models with certain assumptions regarding economic growth, energy prices, etc. but which frequently do not take into account the realities of factors such as political and institutional barriers, have consistently been too high. Interestingly, this consistent optimism has applied both for the nuclear power programs of the countries of the Comecon group as well as for those of other nations. . . . In view of the poor historical record of the methods just described, the approach taken in this report is quite different. There has been an attempt to analyze the situation in each country and to arrive at forecasts of installed capacity which appear to be realistically achievable. Although this approach is qualitative, it is considered to be considerably more reliable than the ones conventionally used." What follows are Interdevelopment's forecasts for installed nuclear capacity in the year 2000 for a number of countries with significant nuclear programs, the corresponding low-case forecast in parentheses of Infce working group 1, and selected comments by Interdevelopment.

Argentina: 3,029 Mw (7,550). Delays of 3–4 years compared with official plans are expected and investment burdens will serve to slow development.

Belgium: 5,450 (9,400) "Although the situation will be clearer after Parliament has debated the nuclear issue, it appears unlikely that there will be any nuclear power plants other than those already in existence or under construction."

Brazil: 3,116 (60,000). "In spite of pressure from the United States, some domestic criticism, and problems with foreign indebtedness, the official government position has been that all plants foreseen under the joint program with Germany will be completed. On the other hand 'Plan 95' of the state company Electrobras, which was issued in 1979, emphasized hydroelectric power and mentions no reactors beyond those under construction or on order. It has therefore been assumed for the forecast that only these three plants will be in operation before the end of the century."

Canada: 22,396 (52,000). Noting declining growth for electricity demand and longer construction times, the report states, "In view of these revisions and signs of increasing opposition to nuclear power in Canada, it is very possible that the forecasts . . . are too high."

France: 83,228 (86,000). The forecast is based in part on operation of gas-cooled units through the end of the century because of the cost of new units, and the absence of breeder operation in this century beyond Super-Phenix.

West Germany: 38,346 (53,800). "For the last decade of the century a modest annual increase of 1,300 Mw is assumed, partly because of the country's coal reserves. Such an increase would probably correspond to a relatively low economic growth rate, something which is anticipated both because of Germany's population pattern and the outlook for world economic development."

India: 2,624 (4,700). "India's high estimate for installed nuclear capacity at the end of the century is 10,000 Mw, of which 3,000 would be provided by fast breeder reactors. In view of delays in the country's nuclear projects and the large investment which would be required, it is unlikely that these capacities will be achieved."

Italy: 5,295 (43,000). "In all, the 10–year energy plan of February 1980 foresees five new stations with two units of 1,000 Mw each in operation by 1990. Although construction will probably be resumed on the units at Montalto di Castro, it is unlikely that the latest 10-year goal can be achieved because of the opposition to new nuclear plant sites."

Japan: 79,536 (100,000). "Although the actual construction time for nuclear power plants in Japan is only about six years, the time from initial discussions with regional officials regarding a site until the completion of a plant is now 15 to 16 years. . . . It is becoming more rather than less difficult to build nuclear plants as witnessed by the increase in lead times over the past several years."

South Korea: 11,698 (42,700). "The reason for [Korea's] interest in nuclear power is clear. On the other hand, the investment required to reach the goal [of 48,000 Mw by the year 2000] is so great that its achievement appears unlikely. For the forecast it has been assumed that in addition to the plants already on order, one unit of 900 Mw will be completed in 1988 and every two years thereafter. Even this forecast . . . may be too high."

Mexico: 10,308 (15,700). "Because of the revenues which will accrue from its oil and gas imports, the country should be in a good financial position to proceed with a nuclear program if it decides to do so. Moreover, it is likely to desire another source of energy against the time when its oil and gas reserves are depleted. It has therefore been assumed that a decision will be reached to add nuclear capacity at a level of 1,000 Mw annually beginning in 1982."

Netherlands: 493 (500). "It is considered likely that stringent energy conservation measures will reduce the annual rate of increase in consumption significantly and that because of nuclear opposition the power plant requirements will be met by the use of coal and oil."

South Africa: 3,688 (4,300). "In making the forecast it has been assumed that in addition to the two units under construction another two of the same size will be added before the end of the present decade. It is further assumed that in spite of the official statements . . . South Africa will decide to utilize its extensive but poor-grade coal reserves for power production to an even greater extent than now planned rather than adding more nuclear plants in the 1990s."

Spain: 16,352 (38,000). "After 1988 it was assumed that 1,000 Mw of nuclear capacity would be added every two years and that the ratio of PWRs to BWRs would remain roughly constant. The assumed capacity additions after 1988 are considered reasonable in view of the likely development of the world's economy during the last decade of the century."

Sweden: 9,410 (0). "It appears likely that the nuclear power program will continue on the basis of 12 reactors."

Switzerland: 4,947 (2,800). "This is virtually the only case in which Interdevelopment's forecast is higehr than Infce's low case, but is still lower than the official Swiss energy plan."

Taiwan: 10,924 (Infce figure unavailable). "It is believed that the growth in electrical demand will be considerably less than present official estimates during the latter part of the century, and the forecast in this report assumes that 6,000 Mw rather than the total of almost 20,000 [projected officially] will be added after 1985."

United Kingdom: 25,480 (27,600). "Although the projection for 2000 is lower than the figure mentioned by the government in its policy statement of December 1979, even it may be too high in the light of the review of nuclear plants which was under way in March 1980."

United States: 139,184 (255,300). "Under the conditions now existing, including the possibility of using coal, . . . it is considered unlikely that there will be any orders for new nuclear power plants in the United States during the 1980s. If there are orders thereafter, they will not affect the installed nuclear capacity during the present century. . . . Moreover, it is believed that the financial risks and the uncertainties associated with the construction of nuclear plants will result in the cancellation of orders for units not yet in the construction phase."

Yugoslavia: 2,615 (Infce figure unavailable). "In view of the investment required for nuclear power plants, it is believed that the additions to capacity will be considerably more modest than [official plans]. It is assumed that two 1,000 Mw units in addition to the plant now under construction will be completed before the year 2000."

Interdevelopment did not attempt to forecast installed nuclear capacity in the Eastern Bloc nations "because of the lack of an adequate information base." Its study was directed by Frank Faris, president of the company, who formerly served as director of reactor development for Atomics International and was a member of the managing board of Interatom until founding Interdevelopment in 1967. The report is available through Interdevelopment at Suite 1014, Rutherford B. Hayes Building, 2361 South Jefferson Davis Highway, Arlington, Va. 22202. The price is $600 in North America and $650 elsewhere.

Mr. WOLPE. In order to put this in perspective, it has been suggested that some of the analyses with respect to uranium supply and demand requirements in the future are ideologically tainted; that is, that depending upon one's perspective with respect to nuclear questions or matters of breeder technology. I just want to try to understand, if I can, your own orientation with respect to nuclear power. I take it that you would not classify yourself in any sense as hostile to nuclear power or the conventional development of breeder technology.

Dr. RATHJENS. Quite the contrary, at least with respect to the first point. I feel it has an important role to play. We have had earlier remarks about the serious consequences of cutbacks in nuclear power, the implications of that for oil consumption.

It troubles me that we, and more importantly, our principal allies, may be more dependent than they otherwise need be because nuclear power will not play as large a part in their case in providing electrical energy as it might. None of these energy options are good. They all have their faults, but given the choice between greater dependence on OPEC oil and some of the serious problems in burning coal and nuclear power, I guess I would argue that we need a mix, with nuclear power playing a significant part of that.

As to the breeder, my own view is that it is an option that we may well want to exploit. I believe that continued R. & D. is important. As I guess I implicitly suggested earlier—I will make it explicit—I do not believe this country now needs to make a decision for commercialization or will need to make it very soon.

Mr. WOLPE. Thank you.

Ambassador Smith, would you have any additional observations to make with respect to the divergence of figures in the INFCE report and our own projections?

Ambassador SMITH. I am very happy to rely on Dr. Rathjens' analysis.

Mr. WOLPE. Thank you very much.

Mr. MCCORMACK. Before we go on with Mr. Wydler's questions, there is one point I would like to make strictly to clarify the record. I do not know of anyone in this committee or before this committee or in the Congress who has advocated near-term commercialization of breeder technology, and I hope we are not arguing that point at any time.

The position of this committee has been that we should be in a position to make an intelligent decision on that subject in the early nineties so that if we feel we must have a breeder technology as part of our nuclear mix, that we will be able to implement it or begin initiating it before the end of the century.

Mr. WOLPE. Will the chairman yield?

Mr. MCCORMACK. Yes.

Mr. WOLPE. I thank the gentleman for yielding.

I think it is important to point out, however, that, first of all, the debate with respect to the breeder, the Clinch River breeder, which is presently before this Congress, has very much hinged on one's understanding about the kinds of questions that are involved in the INFCE projections.

Indeed, one of the major arguments against moving to the Clinch River breeder reactor is that it is not justifiable because it represents a movement toward the commercialization of the breeder technology.

The point I was attempting to establish with Dr. Rathjens is that his testimony is very similar to that of Dr. Hans Bethe, who testified before our committee some time back, who also supports the eventual development of breeder technology, but who is arguing that the Clinch River breeder reactor is simply unwise, and it is based upon an obsolete design.

Finally, the other observation that I would make is that the INFCE study has been advanced by proponents of moving toward a breeder technology at this point in support of those conclusions. So I think it is important to understand the basis upon which the INFCE projections were developed and the divergence between our own projections and those of INFCE and also the divergence between our own needs and circumstances and those of other countries that are member nations of INFCE.

Mr. McCormack. Without objection, I should like to insert at this point in the record a letter dated May 19 from Dr. Hans Bethe directly contradicting the statement the gentleman just made, which has been made available to members of the committee.

[The above-referred information to be furnished the committee follows:]

Cornell University
Laboratory of Nuclear Studies
Newman Laboratory
Ithaca, New York 14853 607-256-4397

May 15, 1980

The Honorable Don Fuqua
Chairman, Science and Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

On May 7, 1979, your committee gave a hearing to a group of scientists which included Dr. Edward Teller, myself and others. This letter is to make some modifications in my testimony in the light of developments during the last year.

The main purpose of my testimony was to urge the vigorous development of some advanced reactor beyond the light water reactor. I left it open whether this should be a fast breeder reactor or an advanced converter, and if a breeder, whether it should be Clinch River or a new design. Among other things I made the following statement:

> "Now, that breeder does not need to be the Clinch River breeder. In fact, the Clinch River breeder is rather obsolete. Such a long time has elapsed between the design of that reactor and the building, so that we probably would be better off to start from the beginning and to have a new design for the breeder.
>
> "I understand that such designs are going forward, at least by two of the major reactor manufacturers."

In the light of developments of the last year I no longer believe the statements in this paragraph, while at the same time I would reiterate my recommendation for urgent development and building of an advanced reactor. The developments are the following:

1. The breeder design efforts which I mentioned in my earlier testimony have come to some conclusion. They have involved five rather than two reactor manufacturers. The efforts have led to a design which is basically a scaled-up version of CRBR (the Clinch River Breeder Reactor). In particular, the new design retains the loop principle, as distinct from the pool design of the French breeder reactor as well as the EBR2. As I understand, the loop design was endorsed because it permits easier access to the reactor in case repairs and modifications should be necessary at a later date. Of course, going ahead with the loop design does not imply any final decision between loop and pool.

2. The INFCE Report has appeared. The many experts from many nations conclude that there is no substantial difference between LMFBR and advanced converters with respect to the ease of diverting reactor material toward illicit manufacture of nuclear weapons. The INFCE report concluded that the nuclear weapons proliferation problem must be solved by institutional and political arrangements, and that there is no easy technical fix.

Once there is no substantial difference between the various advanced reactors with regard to weapons proliferation, the fast breeder reactor is greatly preferred because it insures nuclear fuel supply into the more distant future, while advanced converters can only stretch the supply by at most a hundred years.

3. Industry is in favor of a smaller demonstration plant, about of the size of Clinch River, rather than a plant of 1000 MWe which was the target of the industry design efforts mentioned in Paragraph 1. In engineering devices of this type, it is prudent to proceed by moderate steps which means going from the fast test facility in Hanford to the Clinch River size. Lots of difficulties are likely to occur if we went directly to a 1000 MW reactor. Moreover, the cost of the Clinch River size is clearly much smaller than that of a 1000 MW plant. The General Accounting Office also endorses this argument. CRBR can be brought in much earlier than a larger reactor could be, and because of its somewhat smaller size it will be easier to study its performance and possibly modify it if so indicated.

In view of all these arguments I conclude that the interests of the nation will be best served by completion of CRBR. This does not and should not commit the U.S. to early commercial deployment of a breeder; that decision should be made later on considering the needs of the reactor industry for additional fuel supply.

I should like to make an additional remark on chemical reprocessing of nuclear fuel. Any type of nuclear reactor which is to conserve uranium requires reprocessing, whether it be an advanced converter or a breeder. Reprocessing also gives more options for disposal of nuclear waste: If the transuranic elements are separated from the fission products, the transuranics do not cause much heating and therefore could be easily disposed of in salt such as the WIPP site. The fission products, on the other hand, which do cause a lot of heating have in general relatively short lifetimes, and therefore do not require a repository of quite as permanent stability.

I hope that you will find these remarks useful.

Yours sincerely,

H. A. Bethe

Hans A. Bethe

HAB:vhr

Mr. Wolpe. Let me just clarify, Mr. Chairman. Dr. Hans Bethe is welcome to change his position, but let's be clear that that is what has happened.

Mr. McCormack. The letter specifically corrects the record. If the gentleman has not had a copy of the letter delivered to him, I will see that he gets it.

Mr. Wolpe. I would appreciate it.

Mr. Wydler. You know, Mr. Chairman, this game of electrical projection goes on before this committee year after year, and I get the feeling after a certain period of time that the figures are manipulated to suit the policy decisions that have been made. I do not know really who knows exactly what the electrical projection needs of the world are going to be 10 or 15 years from today.

But it would seem to me that what you are saying and what the witnesses are really saying to this committee is that we can just cut back the electrical projections and, therefore, we can say a lot of things are going to be different in the energy problem than we foresaw them a few years ago.

That is a dangerous game. It is something like what the administration has done with the inflation problems in the country. They simply said we have too much inflation. So what we need is a little recession, and then that will take care of the inflation problem. We will cut back our production and we will cut back our output of things, and so on, and we will take the agony of it. We will have a little less standard of living in our own country as a result of that, but it is worth it because we will solve this inflation problem.

Certainly you can cut back the electric projections for demand in the world and the world can have a lower standard of living. That is really what you are saying. You are going to have less economic development in many undeveloped parts of the world or areas that are on the verge of development. That is a simple thing to do.

As a matter of fact, you could zero it out, if you wanted, and say we are just not going to have any growth at all, and we would not have to worry about any more electrical production of any kind. But the truth of the matter is we should be trying to plan for the possibility that if the demand is there, we will be in a position to provide it.

That seems to me what the sound policy should be, not that we have decided that in 10 years from now, we will not need a breeder reactor. We will make that decision today, and that is what the administration is trying to do.

It does not really follow that policy on anything else. So that really is not the basic gut issue, as I think you gentlemen realize, with the administration's objection to the breeder. It is the one that we heard of years ago, that it was a proliferation problem. That is the real gut objection to the breeder reactor. These other arguments have come along, as that argument fell apart. When that argument could not be sustained and people started to point out how ridiculous an argument it was all around the world, the administration came up with other arguments against the breeder.

And the latest in the series is the one we have today, that we have plenty of uranium so we will not need it and we can make the decision at a later time. Yes, if it all works out the way they say, that is fine. But if it does not, they have short changed the country.

And I suggest to you that you may be part of that short changing because you are making a decision that you really do not know is right or wrong, and you are not letting the country get into a position of taking the option that it might have available if we were to go ahead with the development of our breeder technology. I suggest to you gentlemen that that is what is at the heart of this whole argument and objection that we have had to the breeder.

It is the one that we originally had, and it is the one—if I understood this correctly, Mr. Chairman—I thought that the reason INFCE came into existence was the fact that the administration decided that there was a proliferation problem with the breeder and decided to say well, now let's get the world together and then we will tell them what this policy is going to be. This is our policy, and we are going to convince them at this conference that it is a good policy for them to adopt, too. I thought it was why we really called that conference.

Maybe I am wrong. Then when it started to unravel and all of the rest of the world was saying, in effect, you people must be crazy and we cannot accept what you are trying to put forth as an international policy, we now tried to downgrade it into something, like a debating session in which we got together with the world to debate the issues, and they came out with their conclusions, and we have ours. It makes it sound like there are two positions in the world now, one, the United States, and two, the rest of the world.

And I do not want to be in that position either as a citizen of this country. I would like to be with the world. I think the world is right. and we just keep insisting on these old ideas that we got in our mind some years ago, and we will go down the road with them no matter what, and we will defend them no matter what.

And when I listened to your testimony, it gave me the feeling, "Why did we have that INFCE conference at all?" It was just nothing but a lot of talk. And yet year after year we sit here in this committee and we have the administration witnesses up, and one of the big arguments they always use with us is don't go ahead with the breeder; don't do anything yet. INFCE is going to meet, and they are going to have a report, and as soon as the report comes out, then you can decide what you are going to do. That is what they always tell us.

Now INFCE has decided, and then you tell us it was just a discussion, and it did not mean anything at all. So now we will do what we said we were going to do all the time anyway. What was the whole exercise about, and where are we today that we were not 2 years ago with INFCE?

I do not think we have gotten anywhere, and I think the whole thing was a waste of time. I think if the administration would be honest with the American people, they would go back to their original objective for the breeder reactor, which is the one they really have here inside them, which is the proliferation problem, and defend it or let it go, one way or the other.

They either believe this is a problem still or they do not. They do not want to do that publicly any more, apparently, because they realize they are making themselves look ridiculous in the eyes of the world and in the eyes of many people in this country, too.

But to try to bring up these other arguments about possibly not needing it and so on, I think that is really unfair to the American people because you may need it. And if we do need it, we should be in a position to use it. And we are not allowing our country to get into that position.

I, as an American, cannot understand the sense of it. I do not want to put you on the spot for trying to defend these policies, and I know you did not make them up, and your job is to carry them out. And I know that you have been doing a fairly good job in bringing some light into that area of darkness that I see in our national policies here.

But can't you get it through to the minds of these people down there that every way you can find out that we are losing, every way. We gain nothing; we lose everything. What is the sense of the policy? Hasn't the time come to say it is not working, and we are going to do something different? Why can't we do that?

We are grown up people. It would seem to me the moment has come to admit that the policy is not useful. It serves no national interest. Let's get on and get a sensible policy together, something along the lines of what I saw a glimmer of in your statement about having some kind of flexibility in it and being able to recognize who our friends are and being able to treat a country like a mature, grownup individual, and so on, just sort of commonsense things.

Mr. McCormack. Ambassador Smith, do you wish to comment?

Ambassador Smith. Well, as I see it, we are talking about two aspects of the problem: One, what the American program should be like, whether $300 million or $500 million should be in the breeder budget, or whether Clinch River should be gone ahead with or not.

Here I do not think we have any competence to go into that matter.

And the second question is: How about our international policies and shouldn't they reflect INFCE? As I said in my statement, we are committed to take into consideration INFCE findings. The administration is in the process of thinking these problems over, and I am in no position, even in response to such an eloquent plea as yours, to say where they are going to come out.

Mr. McCormack. Ambassador Smith, you said on page 6 of your statement, and I quote:

> I do not believe that INFCE itself produced any data or analysis which substantially changed U.S. perceptions about the potential role or reasonable time scales for the various fuel cycles in the United States. For example, the uranium producibility for the United States was not specifically reviewed by others.

Now, I distinctly recall the administration position that was enunciated when President Carter attempted to stop our breeder and reprocessing program. He said, and there are four points: One, the proliferation threat of building Clinch River; two, that if we set this example by killing Clinch River, the rest of the world will follow us and kill theirs; three, there are other technologies for reprocessing that are safe as far as weapons proliferation is concerned, other than the LMFBR uranium-plutonium technology; four, there is plenty of uranium available so we do not need to reprocess or to have breeder cycles.

He specifically pointed out or hinted to the fact that thorium as a fuel would be a nonproliferation fuel annd that the Candu reactor was proliferation resistant and the gas-cooled reactor was proliferation resistant.

Now you say that you do not think INFCE itself has substantially changed perceptions. All of those perceptions have changed since the administration has made that statement. The administration has, one by one, dropped or repudiated either directly or by silence, every one of those predictions. This happened during the time INFCE was going on.

I am curious to know what happened, and do you know why the administration has changed its position to the point where it says now the only argument against the breeder is an economic argument?

Ambassador **Smith**. I think that one of the points you made—I do not know what document this is that you are quoting from——

Mr. **McCormack**. It was the Ford-Mitre report that the President was passing out. They were repeated by witnesses sitting where you are sitting.

Ambassador **Smith**. George was an author of the Mitre report, and maybe I should ask him to speak to it.

Mr. **McCormack**. Dr. Rathjens.

Dr. **Rathjens**. I will try. You may have to remind me of your points. I think I can remember the last three.

You are concerned with the suggestion that if we dropped Clinch River, others would follow suit. I do not think we said that in the Ford-Mitre reports, and I certainly never believed it. And I guess I said in the first part of my statement today that when INFCE began, I certainly did not expect other countries with a commitment to the breeder to necessarily drop it, no matter what we did.

As to the question of thorium fuel cycles and their relative proliferation resistence, I never held the view that they were necessarily superior to those involving plutonium and uranium exclusively. I think there was some belief in this country, and indeed, a great deal of enthusiasm, for those kinds of cycles based, in part, on a belief that they had an advantage from a nonproliferation perspective. I never believe it. I do not think my colleagues who were involved in the Ford-Mitre report took that position, and INFCE did not take that position.

Now, on your fourth question, the one of uranium availability and supply, if I remember correctly, the Ford-Mitre position was that probably we would have enough uranium available so that a commitment to breeders could be delayed until some time in the next century. I think that is probably correct, and there is more reason to believe that is correct now than at the time it was written simply because the projections for the growth of nuclear power are realistically and, I think, unfortunately lowered.

Now, you would have to remind me, Mr. Chairman, of your first of four points, if you would.

Mr. **McCormack**. I think the one I have mentioned which you have not mentioned is the one that if we took this lead, the other nations of the world would follow.

Dr. **Rathjens**. I did not think that would be true. I think the position—trying to present the position of my colleagues who participated in the study—would be that some would argue that if we did not do it, they certainly would not. If we did do it, they might or might not.

In my own view, it would be a differentiated one that probably, for example, would have an impact on some and little impact on others.

Mr. **Wydler.** May I ask one more question, Mr. Chairman?

How do the projections for uranium in the Soviet Union look? They have quite a bit of uranium there; don't they?

Dr. **Rathjens.** I regret to say I have no idea, and I think one of the most unfortunate things about the whole INFCE exercise is that the Soviet Union was almost totally unwilling to provide any significant data on anything and, as a result, all of our work——

Mr. **Wydler.** I realize that. I asked some questions about their program, too, and they gave me a blank stare, but we have our own projections, I guess, which the CIA or somebody has made. Somebody has done it, and I have seen them. They seem to have a tremendous supply of uranium, and they are planning a great many light water type reactor plants in the Soviet Union, as we know, to utilize it.

But I just wonder with that situation in their country why they have not come to the conclusion we have. It is strange to me they have not concluded we have all this uranium, and why don't we just keep building light water plants. Why don't we forget about the breeder like the United States and follow their very intelligent decision on that? We won't have a breeder either; we do not need it.

Brezhnev is not the President of France either. Our own President has said that if he were the President of France, he would build a breeder. Why is Brezhnev so misled, do you figure, in deciding that in spite of the situation he has, that he is going to go ahead and build the breeder reactor?

Dr. **Rathjens.** I just have no basis for commenting because I do not know what their supply-demand situation is.

Mr. **McCormack.** Ambassador Smith and Dr. Rathjens, I want to thank you for coming here to testify here today. We obviously have only skimmed the surface. I probably have written down 50 questions on the margins of your testimony as I was listening to you present it, and with your permission, we shall submit questions to you in writing, which I trust you can answer in the not too distant future.

We may be contacting you again for more information. I realize we are trying to cover a subject in a short time that you have spent several years on, and that we have spent several years on here in our own position relative to it.

We look forward to working with you and are hoping that the policies of this country will move forward and give this country the benefit of the potential for nuclear power, and that we may, indeed, take a position of responsible leadership in the world not only in stimulating the peaceful use of nuclear energy, but also protection against the diversion of material for any terrorist or military purposes.

I want to thank you very much for coming today.

Our next witness is Dr. Lawrence Scheinman, who is currently director of the program on science, technology and society and professor of government at Cornell University.

In 1977 and 1978, Dr. Scheinman served as senior adviser to the Under Secretary of State for Security Assistance, Science and Technology. He is one of the key officials involved in the planning, development and implementation of the U.S. nuclear nonproliferation policy.

He also served as U.S. representative to INFCE working group 3, and currently is a consultant at Department of State and Department of Energy.

Dr. Scheinman, we look forward to your testimony, and we welcome you today.

We have a copy of your testimony before us. It will be included in its entirety in the record, and you may proceed as you wish.

[A biographical sketch of Dr. Scheinman follows:]

Brief Résumé of Dr. Lawrence Scheinman

Dr. Lawrence Scheinman is Director, Program on Science, Technology and Society and Professor of Government at Cornell University. From January, 1977 through September, 1978, he served as Senior Advisor to the Under Secretary of State and Deputy to the Deputy Under Secretary of State for Security Assistance, Science and Technology. He was one of the key officials involved in the planning, development and implementation of United States nuclear nonproliferation policy. During his tenure at the Department of State he served as chairman of the interagency subcommittee on Nuclear Fuel Assurances, and of the interagency subcommittee on Spent Fuel Storage. He had a major responsibility in the United States-Japanese negotiations during this period and served as U.S. representative to INFCE Working Group Three (Assured Supply). He currently serves as a consultant to the Department of State and the Department of Energy.

Prior to joining the Department of State, Dr. Scheinman was Senior Policy Analyst and head of International Policy Planning at the Energy Research and Development Administration, and one of ERDA's principal members on the Fri Task Force nuclear evaluation in the Ford Administration. To assume Government service, Dr. Scheinman took leave from Cornell University where he was Professor of Government and Director of the University's Peace Studies Program.

Dr. Scheinman has taught at the University of California at Los Angeles and at the University of Michigan where he took his doctorate. He has been a Fellow of Harvard University's Center for International Affairs and the 1969–1970 Visiting Research Scholar at the Carnegie Endowment for International Peace. He has published extensively in the field of regional and international organization, nuclear cooperation, nuclear non-proliferation policy and international safeguards as well as on French politics and International Law. He is a member of the Council on Foreign Relations and the International Institute of Strategic Studies, and has been a participant in international and regional meetings of the Pugwash Conference, as well as a member of the International Affairs Consortium of the Aspen Institute. He was trained as a lawyer and is a member of the Bar of the State of New York.

STATEMENT OF DR. LAWRENCE SCHEINMAN, DIRECTOR, SCIENCE, TECHNOLOGY AND SOCIETY PROGRAMS AND PROFESSOR OF INTERNATIONAL POLITICS, CORNELL UNIVERSITY

Dr. **Scheinman**. Thank you very much, Mr. Chairman. I will try to move with dispatch through my remarks which are based on the statement that I did submit, and I hope in light of the discussion that has just taken place that I might be able to shed some further light on the origins of INFCE, its purpose, with a view to clarifying why one can or cannot call it a success in varying degrees. I've been asked to give my perspectives on the origins, its purposes and also to make some observations about implications. I would just like to indicate that the initial portion of my testimony will be based on perspectives drawn from my Government service in the Ford and Carter administrations.

My current and future assessments reflect the perspective of a private citizen. I would like to emphasize that there are four basic elements in any nonproliferation policy if it is going to be effective in the long run: controls, in the form of safeguards; restraints of the type that we have seen emanating from the London suppliers group and other national policies; incentives, very importantly, such as the development of a stable and competitive market and assured supplies of nuclear fuels and services for countries meeting nonproliferation conditions; and, finally and most importantly consensus building as exemplified by the international nuclear fuel cycle evaluation exercise, INFCE.

I personally believe that consensus building is the most important element because it is the source of legitimacy which in the last analysis is essential to a stable and effective nonproliferation regime. INFCE quite properly then is regarded as a very central element of U.S. nonproliferation policy. But it is important to bear in mind that while it officially was first announced by President Carter in April 1977, it really has deeper roots. It is to be found in policy commitments of the Ford administration, based on the report of the FRI task force and on a more general level in the spirit of U.S. nonproliferation policy itself as it has evolved over time, so that it really is part of the policy and only can be understood in the context of that policy.

In 1954, as we well know, the United States abandoned the strategy of technology denial, which has been cited today as the policy to which we've returned and concerning which I think there is some nuance. That policy worked rather well for a period of 20 years and three things emanated from it: a system of international safeguards, a growing presumption against the legitimacy of proliferation, and an increased confidence in the nonproliferation regime itself.

It is equally familiar to members of this committee that in the early and mid-1970's a series of events occurred which shook our confidence in that system. These included such things as the Indian detonation, accelerated interest around the world in plutonium fuels, itself largely a result of the energy crisis that we were all confronting at the time, and the spread of sensitive technologies to countries for which it appeared very unjustified in economic terms but from which could flow serious proliferation implications.

American policymakers in 1974, 1975 and 1976 were concerned that potential nuclear weapons material or the technology to produce it might proliferate in uncontrolled fashion around the globe and they were very uncertain about the effectiveness of the prevailing nonproliferation and international safeguards regime to deal with these more sensitive fuel cycle activities. And, as a consequence, national policy became one of the initiating measures either unilaterally or in multilateral fora aimed at avoiding the emergence of a situation over which the international community ultimately might lose control, in short, aimed at avoiding the threat that technology would ultimately outdistance social controls.

As a result, a number of measures were taken, again, measures that we are all familiar with but which are historically important. One was the London suppliers group which was important because it provided a basis for strengthening and standardizing nuclear safeguards and reducing the risk that they would become bargaining chips in commercial competition.

Additionally, there were bilateral and multilateral discussions inside and outside the framework of the London group regarding the possibility of enhancing nonproliferation measures above and beyond international safeguards controls. This led to controls on sensitive nuclear exports.

And, finally, there were independent declarations by a number of governments, among them, France, the Federal Republic of Germany, the United States, Canada, and Australia regarding the conditions for the transfer of sensitive technologies and facilities in the future.

At the national level President Ford called for a reassessment of our own thinking about our own national strategy with respect to nuclear development. And as we know, one of the results of this was a conclusion, resulting from the FRI Task Force report, that the United States would no longer regard reprocessing of spent nuclear fuel to product plutonium as a necessary and inevitable step in the fuel cycle and decided that reprocessing and recycling should not proceed unless there were sound reasons to conclude that the world community could effectively overcome the associated risks of proliferation.

Now this is a decision taken on October 28, 1976 and it led to a call for a reprocessing and recycle evaluation program shortly thereafter. That reprocessing and recycle evaluation program remained inchoate during the final months of the Ford administration, but I believe it can be properly regarded as the lineal ancestor of INFCE.

These events had an international impact to be sure. We've been discussing those impacts for the past 2 hours. Characteristic of all these measures is restraint and limitation. This ran counter to the pattern of increased and broadened nuclear cooperation which had dominated the preceding decade. And it came at a time when everybody was concerned about energy security. One result was that the smaller states and developing countries which were just on the threshold of nuclear development tended to regard these actions as inconsistent with the commitments of the Non-Proliferation Treaty, as discriminatory and as an example of advanced industrial states seeking to preserve technological benefits to themselves to maintain the prevailing economic distance between the First and Third Worlds. Resentment began to build.

What some of these countries, but not all, failed to appreciate was that none of the measures that were taken in this period of time in any way intended to or did in fact affect the really important transfers of reactors and nonsensitive fuels, but only the symbolically attractive and economically questionable technologies bearing high security risks, such as enrichment and reprocessing technologies. They mostly failed to recognize that these methods were not ends in themselves but only first steps toward preventing the further erosion of the international nonproliferation regime and toward beginning a reconstruction and strengthening of a new and stronger regime based on mutual agreement and consent that would facilitate increased international cooperation.

Nevertheless, and the reason for my stressing these points, their sense of alienation was extremely important and it was a very distinct element in the decision to launch an international nuclear fuel cycle evaluation.

The reaction that I've just cited with respect to developing and Third World states and smaller industrial states also found its way into the feelings of the advanced nuclear countries, most of whom had modeled their nuclear programs after the U.S. program and consequently had anticipated commercial fuel reprocessing and recourse to plutonium fuels.

Some of those countries were already well along the way to developing their commercial activities, and others were about to embark in that direction, for example, Japan. Obviously these countries were agitated at the fact that the United States had begun to reassess its own use of plutonium, because in light of the fact that most of our agreements for cooperation contained prior approval rights over the reprocessing of U.S.-origin fuel by other countries, what we did with respect to our own fuels obviously would be seen as having an impact on fuels of other countries.

Mr. McCormack. Dr. Scheinman, the bells have rung for a vote. We should like to recess now for a few minutes and go vote and come back. If all goes well, we should be back in about 10 minutes.

Dr. Scheinman. That's fine.

[Recess.]

Mr. McCormack. The meeting will come to order.

We had two votes rather than one, which accounts for the delay. Dr. Scheinman, can you pick up where you were?

Dr. Scheinman. Thank you, Mr. Chairman, I will.

I think it might be useful at this point simply to try to summarize the origins of INFCE very quickly and then move on to the balance of my discussion. I would summarize it essentially in this way.

Having reviewed nonproliferation policy in the early months of 1977 and having concluded that serious risks were inherent in current policy and in need of review and possible revision and having recognized that the United States had only limited leverage over others and in any event could not dictate behavior on the part of others and was itself incapable of providing all the answers to questions it had raised regarding nuclear energy and proliferation; seeing that there was a genuine need to step back from an increasingly politicized and polarized debate over nuclear development strategy and to establish just what the facts of nuclear demand, supply, technological development and institutional opportunity were; and having already committed itself through the previous administration to carrying out a reprocessing evaluation program, the Government decided to first internationalize that evaluation, opening it to all interested parties and second, to expand its scope to include the entire nuclear fuel cycle from basic resources through advanced reactor development to management of nuclear wastes.

INFCE became declaratory policy in April of 1977. It was proposed formally at a London summit in May, and inaugurated later that year in Washington. During that period the methodology and structure as well as the ground rules of the study were discussed and finalized. I think it is important to note that no fundamental changes in terms of objectives or expectations occurred but that a number of assumptions and elements were made more explicit. In particular, it was agreed that the study would be limited to a duration of 2 years, that ongoing programs would continue unaffected by the INFCE study, that new initiatives and programs which might be affected by the outcome of the study would not be undertaken during its period and that its results, though not binding on governments, as Ambassador Smith pointed out, would not be prejudged by the participants. In sum, I think INFCE's organization and agenda largely reflected American preferences and concerns.

There are, Mr. Chairman, many ways to define the purpose of INFCE, a number of which are suggested from the discussion of its origins. Definitions of purpose, of course, bear significantly on assessments of outcomes. I believe that at the broadest level INFCE was intended to reestablish in the minds of the governments the importance to international nuclear cooperation of a stable international regime and the understanding that if we are to preserve for society the benefits of peaceful nuclear energy—and I underscore those words, "preserve for society the benefits of peaceful nuclear energy"—a balance must be maintained between that technology and its related social controls.

INFCE's purpose in this sense was to bring together suppliers and recipients, advanced and developing countries, weapons states and nonweapons states, to examine the problems of organizing the fuel cycle in such a way as to meet energy concerns without contributing to proliferation. It was not intended to provide magic solutions but to establish a sound and agreed factual base upon which a consensus could be built and states could negotiate acceptable agreements and conditions for international development and cooperation.

I would like to note here, Mr. Chairman, that it must be kept in mind in all discussions of INFCE that all it is doing is providing a base upon which the really serious negotiations and discussions and agreements ultimately might be based.

Energy differences and disparities in the degree of external dependence and alternative domestic energy resources, and resulting differences of degrees of sensitivity to the implications of proliferation and the relationship of the commercial fuel cycle to picking up a later military option, all underscored the need for establishing an agenda to review the risks and to assess the alternatives.

INFCE's success or failure should be measured against that criterion and not against the extent to which other countries abandoned their nuclear energy plans and marched exclusively to the beat of the American drum. Success does not require an identity of interest but only a convergence with regard to certain fundamental points. This is not agreement at the lowest common denominator but rather at that level which optimizes between agreed basic values, in this case, nonproliferation and energy security.

Others this afternoon have addressed explicitly the results of INFCE and the support for and divergence from U.S. nonproliferation policy that it reflects. So without engaging in any detailed discussion let me just say that my own view is that the balance sheet does report in our favor. Powerful centrifugal forces were at play in the mid to late 1970's, threatening to polarize the nuclear debate, to irretrievably weaken the nonproliferation regime and to obscure many of the basic issues and questions. INFCE caused a discontinuance of that trend and transformed acrimonious debate into constructive dialog. Though not tangible in policy terms, I don't think you can underestimate this result.

Without that shift, rational discussion on particular issues would not have been possible and would not be possible in the future. The level of consciousness regarding proliferation risks associated with various fuel cycle activity has been significantly raised and nonproliferation considerations are now generally accepted as important factors in making fuel cycle decisions.

Measured in these terms I really believe we must judge INFCE a success. At the more specific level it appears that the urgency regarding recourse to plutonium as a fuel, particularly for light water reactors, has virtually disappeared, and that economic and technical dimensions of breeder reactor development are now more fully appreciated with the result that many countries, particularly the smaller and developing ones, may want to take a closer look before taking a plunge.

Concern that uranium resources were running out and would not be available has been alleviated, and the view that reprocessing is a necessary waste management step because spent fuel disposal is not feasible has now been altered.

There also is clear recognition that safeguards alone may not be adequate to achieve nonproliferation objectives in all situations and that additive measures may consequently be necessary. But, most importantly, the sense of concern about maintenance and strengthening of an effective nonproliferation regime is now much more widely shared than before and there is a basis for measured rational and comprehensive discussion about the timing, conditions, and technical implications of fuel cycle decisions.

Let me now turn to two questions, Mr. Chairman, regarding the future. I have been asked to address INFCE's implications for international safeguards and let me take that question first.

Considerable emphasis was placed on the importance of effective international safeguards in the INFCE deliberations. If there was ever a doubt as to the centrality of safeguards to a viable regime of international nuclear cooperation, development, and commerce, it was utterly dispelled by the strong endorsement of virtually all the participants.

INFCE did not closely examine the adequacy of implementation of current safeguards, and in its general review it did not identify any significant problems with the capability of existing methods and techniques applied to existing facilities. While this is generally regarded as a fair assessment, I think it should be noted that with the present facilities under its responsibility the agency is just barely able to provide the kind of assurances considered acceptable, just able to keep its head above water. Financial resources are limited. Progress in containment and surveillance technology is unconscionably slow. As to the application of safeguards to facilities providing access to weapons-usable material such as enrichment plants or bulk-handling facilities INFCE readily acknowledged that much work needed to be done; and with regard to reprocessing facilities, while a number of approaches were identified, no consensus emerged on any single one.

There is in the safeguards community to date, to be quite frank, some uncertainty as to the extent to which safeguards can grow with the growth of complex facilities, a point of view that I think is sobering and a constant reminder of the depth of challenge that technology poses to society.

In assessing the needed improvement and potential effectiveness of safeguards for application to new fuel cycles, that is to say, where can we put our money, a distinction usefully can be made between improvements which are intrinsic to safeguards and those which are extrinsic. There is no question but that a number of intrinsic improvements are needed for current safeguards, largely in the technical and administrative areas.

I would cite five:

One is the improvement in the quality and flow of information.

The second is identification of measures, actions, and resources necessary to facilitate the taking of corrective steps to improve that effectiveness.

The third is the development in clear and concise terms of the technical objectives of safeguards and the criteria by which their attainment would be judged, particularly where new safeguard tasks are defined.

Fourth is developing and improving the availability of safeguard technology that can be deployed by the IAEA, including equipment and techniques on the one hand and optimal facility design to accommodate effective safeguards on the other.

In the case of surveillance equipment, where much emphasis is now being placed, this would include designing those pieces of equipment to military specification which has not been the case up to now.

And, last, because of the salience of state systems of accounting and control to efficient and effective safeguards implementation by the IAEA, there is a great need for appropriate technical training and administrative measures to improve their quality. Another measure which does not involve R. & D. but which is central to the strengthening of international safeguards in general is adoption by suppliers of a policy requiring full scope safeguards as a condition of nuclear cooperation.

While we have yet to achieve global accord on the requirement that a recipient country have all of its nuclear activities under international safeguards as a condition of supply, this standard is receiving consistently wider support. Full-scope safeguards are, of course, characteristic of the NPT regime to which over 100 states now adhere. It also has been adopted as an export criterion for all exports from the United States after March 1980. The offers by the United States and the United Kingdom to submit their peaceful nuclear activities to IAEA safeguards, on which the world continues to await final action, reinforce the concept underlying the full-scope safeguards.

When considering the effectiveness of safeguards for breeder fuel cycles and/or plutonium recycle, I think another dimension must be added to our assessment of international safeguards. These are what I would call extrinsic measures. These measures are largely, but not entirely, institutional in character. They involve adoption of principles limiting the number of sensitive fuel cycle facilities; linking the deployment of those facilities to actual requirements; insuring that any new facility involved in sensitive activities incorporate state-of-the-art technological and institutional proliferation barriers; storing, under international arrangements of separated plutonium that is not absolutely essential to meeting breeder and advanced reactor research and development requirements, where those activities are initially regarded as legitimate; and adopting sensible rules of the game for conducting advanced nuclear research. In my mind, that would include the possible development of some international centers of research activity in the sensitive areas.

In effect, what extrinsic measures can accomplish is to mitigate problems that even the most perfect conventional safeguards would leave unresolved, problems associated with widely present or easily accessible directly weapons-usable material. While extrinsic measures will not mean achievement of a risk-free nuclear fuel cycle—and I think we would all agree that that particular ideal does not and cannot exist—they can contribute to substantial reduction of proliferation risk.

Finally, Mr. Chairman, there is the question of INFCE's implications for U.S. cooperation with other countries in R. D. & D. on nuclear power. Much can and will be said on this matter and I would simply like to offer my list of priorities. Underlying this is a basic philosophical point of view. Unless we can manage to solve the problem of public acceptance of nuclear power, there will be little reason to contemplate cooperative research and development in advanced technologies for there will be no nuclear industry upon which to base such research.

Withdrawal of public support of nuclear power could under certain circumstances have serious effects on energy security, possibly bringing in its wake heightened economic pressures and increased international tension. Certainly, this risk is high in the absence of the establishment of a set of clear and realistic alternative goals for energy development specifying the roles of oil, coal, synthetics and solar sources of energy.

In the nuclear sector I believe there are five areas to which emphasis should be given, one of which is not entirely R. & D. but relates to the establishment of a stable nuclear marketplace which can contribute to defining R. & D. emphasis. These areas are respectively nuclear reactor safety; effective management of nuclear waste, both in the sense of spent fuel storage and the disposition of high activity waste; improved safeguards including technical cooperation in enhanced materials accounting, containment, and surveillance, improved utilization of uranium in light water reactors; and improved capacity to offer timely, competitive low-enriched uranium on attractive terms and conditions.

Safety and safeguards are either self-evident or already discussed. About waste management, a great deal needs to be done and there is little dispute about it. The problems associated with the management of radioactive waste materials and the public's perception of these problems have impeded nuclear power growth. The scientific and technical aspects of waste disposal strategies are ideal targets of opportunity for R. & D. cooperation, including investigations of categories of sites for disposal, the development of barrier concepts for stored high activity waste, as well as its packaging, transportation and solidification. Equal attention needs to be given to the safe and efficient operation of spent fuel storage facilities. And there is ample opportunity and need to initiate research regarding the ultimate disposal of waste in spent fuel form.

INFCE acknowledged that potential improvements in light water reactor technology could lead to savings of 10 to 15 percent in uranium utilization without undue economic or safety consequences, while leaving open to question whether further improvements were economically feasible and timely.

At a minimum, however, there would appear to be substantial opportunity for cooperative R. & D. on near term improvements which could be retrofitted into existing LWR's and longer range improvements which might be incorporated into reactors yet to be built.

In addition, it is clear that more needs to be done in the way of exploratory activity for uranium. Analysis indicates that accessibility of uranium is as much if not more of a problem than its physical presence. And this is a political not a technical problem. However, much ground remains to be covered in bringing greater precision to estimates of uranium resources at differing price recovery levels.

With regard to assured supply of low-enriched uranium, it should be clear to most people that our time of troubles in the international nuclear marketplace dates not to the hardening of our nonproliferation policy but to the closing of the order books in 1974. This encouraged development of competitive sources of supply, such as Urenco and Eurodif, contributed significantly to perceptions of supply uncertainty, and helped to stimulate interest in recovery of residual energy values from spent fuel.

Even today, we have not yet taken the important steps to reestablish ourselves as a supplier of the first order of timely and competitive low-enriched uranium. I believe this deserves early attention and, in addition, that serious consideration should be given to exploring, on an international basis, interest by others in participating in the development of our planned new enrichment project, giving them a direct stake and equity share in part of our enrichment capacity.

For countries adhering to agreed nonproliferation conditions it should be possible to negotiate a mutually acceptable arrangement affording direct participation in the supply system and export license arrangements designed to establish confidence and predictability. This is a subject that was discussed to some extent in working group 3 of INFCE. Among other things, this could help further alleviate pressures toward excess diversification of technologies which entail proliferation risks, and to stabilize nuclear relations.

To conclude, cooperation in all of the above sectors deserves priority consideration in the post-INFCE period. To repeat, if the public cannot be persuaded that current energy technology can offer significant benefits at acceptable social and economic costs, there will be no opportunity even to test the premises and whatever comparative advantages may exist in more advanced nuclear technologies.

Thank you.

[Additional questions and answers from Dr. Scheinman follow:]

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
SUITE 2321 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, D.C. 20515

June 10, 1980

Dr. Larry Scheinman
Professor of International Politics
Cornell University
Ithaca, New York 14853

Dear Dr. Scheinman:

Thank you once again for appearing before the Subcommittee on Energy Research and Production during our June 4 hearing on the International Nuclear Fuel Cycle Evaluation study and the implications for future nuclear energy research and development. We found your testimony particularly insightful and useful, and we sincerely appreciate you sharing your expertise with us.

During the hearing, we indicated that the Subcommittee might request some additional information in the form of further questions. Having reviewed the testimony received at the hearing, we find that additional information would be very helpful. Accordingly, we would appreciate your providing, for the record, responses to the enclosed questions.

Your prompt reply would be most appreciated. Thank you for your cooperation on this matter.

Sincerely,

Mike McCormack

MIKE McCORMACK, Chairman
Subcommittee on Energy
Research and Production

MM/Cwm

Enclosure

QUESTIONS FOR
Dr. Larry Scheinman
following
INFCE HEARINGS
June 4, 1980

1. What unspoken goals and expectations did the Administration have for INFCE?

2. How would you characterize the differences in the fundamental cases for the non-proliferation initiatives taken by Presidents' Ford and Carter?

    a. You were in the government when President Ford made his October, 1976 announcement on the back-end fuel cycle operations?

    b. Weren't you aware that as a follow-on, Secretary Seamans was putting together a package for President Ford under which back-end operations would be conducted under government auspices, as has been the trend in other countries?

    c. Wouldn't you say that was a fundamentally different kind of approach than the absolute prohibition of this Administration?

3. IAEA safeguards.

    a. What new light does INFCE put upon safeguards as a way to control proliferation risks?

    b. What can the U.S. do to show it is now willing to take a constructive attitude?

4. What groups, individuals and reports had the greatest influence in establishing the current Administrations non-proliferation policies? Is there an ideological base underlying these influences and policies?

5. Was INFCE a success?

    a. Was INFCE a success and if so why - please be specific.

    b. Has U.S. influence abroad increased or decreased as a result of INFCE?

6. If we enter into new nuclear cooperation agreements and supply contracts, do you believe we should guarantee performance of these as long as the other party meets his obligations? If we do not do so, why would anyone be willing to enter into new agreements with us?

Dr. Larry Scheinman
Cornell University

Answers to Questions - Subcommittee on Energy Research & Production, House Committee on Science and Technology

1. INFCE goals and expectations.

I believe that the Administration's goals and expectations for INFCE were those reflected in the statements surrounding initiation of the evaluation idea -- to achieve greater international understanding of the non-proliferation and energy security implications of fuel cycle decisions; to sensitize states and decision-makers to the complexities and risks associated with particular technological developments and of the need to avert the risk of technology outpacing social controls; and to establish a factual data base from which to evaluate program development strategies and the costs and benefits of different alternatives. Clearly, the US hoped to persuade others of the importance of maintaining an effective protective regime, and of some of the deficiencies in the present regime, and consequently of the advisability of reassessing the timing and conditions for introducing high-risk technologies using materials which could be diverted to military purposes. Thus, it hoped to achieve agreement on objective review of some conventional wisdom which had accrued over the years but which the US believed should be reassessed in light of evolving political, economic, security and related considerations.

2. Differences between Ford and Carter Administrations.

I do not think proliferation questions were taken any less seriously by the Ford Administration than they were by the present Administration. In a real sense, current policies were logical extensions of evolving assessments and analyses which began as early as 1975. It is not correct that a package for evaluating backend fuel cycle operations had been put together under the Ford Administration. Rather, the scope and characteristics of a Reprocessing Evaluation Program were under review and study but no final decision on how to proceed was ever taken at least to my knowledge. While a second Ford Administration might have proceeded somewhat differently than the Carter Administration did, it is really difficult to say just how much divergence there ultimately would have been. Among the uncertainties was the possible role of the Barnwell reprocessing plant. I do not believe it to be a forgone conclusion that Barnwell would have played a significant role in a REP, and certainly would not have done so until a good deal of assessment such as was carried out in INFCE had been undertaken, evaluated and digested.

3. IAEA Safeguards.

INFCE recognizes that international safeguards are a necessary, but not always sufficient means to control the risk of proliferation. Importantly, it places the participating states on record as supportint the need to strengthen and improve those safeguards. The US has always been in the forefront of states contributing to development of effective safeguards, and has a major stake in continued efforts in this direction. One useful step now would be early implementation of the US offer to place peaceful facilities under IAEA safeguards; another would be to take initiatives to study and evaluate optimal integrated safeguards systems, and a third would be to continue to offer US R&D facilities in support of international safeguards development while encouraging other technologically advanced states to do the same. The US also should press for effective national systems of accounting and control as a basis for more effective IAEA safeguards, and it should continue to encourage universal adoption of the principle of "full-scope safeguards."

4. Influence on Policy.

The current Administration's non-proliferation policies reflect a wide array of views from relevant Government agencies and departments, and from respected outside authorities. The Ford/Mitre study as well as some studies produced under the auspices of Pan Heuristics have received notoriety as being particularly influential in shaping policy, but it is a gross oversimplification to ascribe policy outcomes to those sources alone. Many of the key elements of current policy were in various stages of conceptualization, development and implementation before publication and dissemination of the aforementioned studies, and the latter were in turn clearly influenced by the ongoing dialogue. If there is an ideological base to this Administration's policy it is to make the use of nuclear power consistent with non-proliferation concerns and to keep the dispersion of sensitive materials and production facilities in balance with social and political controls, and to think innovatively about institutional arrangements to achieve that goal.

5. Was INFCE a success?

I believe INFCE was a success for a number of reasons including:
-it clarified a number of misconceptions by others of US nuclear policy and objectives;
-it contributed importantly to easing tensions, to establishing a dialogue and to placing issues in a constructive framework for analysis;
-it established beyond question the importance of giving serious and sustained consideration to the proliferation implications of fuel cycle decisions;
-it dispelled some earlier notions about the urgency of reprocessing for waste management purposes and established the feasibility of spent fuel disposal;
-it highlighted some economic realities about breeder reactors and associated fuel cycle activities which before were given inadequate thought and consideration and also placed plutonium recycle issues in a more realistic perspective.

I believe that in creating a framework for constructive dialogue and narrowing the issues that divide countries, INFCE helped to increase US influence abroad, and certainly to stem erosion of that influence which flowed from misunderstanding. It has enabled the US to explain its views and concerns in an objective and dispassionate manner, and it has established a basis upon which to deal with specific issues and to develop institutions and rules of the game that can facilitate continued international nuclear cooperation.

6. Cooperation and guarantees.

Arbitrary and capricious political intervention in nuclear cooperation agreements is not consistent with international cooperation. However, we all must be realistic and recognize that technical and political conditions can change and that these changes may require reassessment of the adequacy and effectiveness of prevailing non-proliferation measures. A means must be found, and institutionalized, to permit that reassessment to take place and to facilitate necessary adjustments. We are still far from a universal code of conduct and must maintain some control over the terms and conditions under which our assistance is used.

Mr. McCormack. Thank you, Dr. Scheinman.

Dr. Scheinman, on page 3 you discussed the origins of INFCE and I would like to ask you, in your opinion, was the concern for proliferation the real reason for President Carter's April antibreeder, antireprocessing position, or was it something else?

Who really suggested INFCE? Who wanted it? Can you answer those questions for me?

Dr. Scheinman. I can try, Mr. Chairman.

I would say that there was a very broad consensus within the American political community in 1977 that the proliferation problem was a very serious one, that the barrier that international safeguards had provided between military and peaceful uses of atomic energy was really very shaky, and that unless we did something to try to stop the continued erosion of those barriers, we would find ourselves in a position from which we could not easily extricate ourselves and what was essential at that time, therefore, was to try to put the brakes on, stop the merry-go-round from moving or stop the train from leaving the station, if you will, and try to assess the situation we then confronted and see whether and to what extent we could find a way in which to deal with the important issue of developing nuclear energy without, at the same time, increasing the risks of proliferation.

I would say that that was really a very profound and very widely shared perspective. It played a significant role in deciding to launch the INFCE exercise.

Mr. McCormack. At that time in 1977, the projections were that—is it 1977?

Dr. Scheinman. 1976 and 1977.

Mr. McCormack. At that time, the projections were that there would be 500 times as much plutonium produced from conventional nuclear powerplants as would be from Clinch River, and yet the President seemed to say that Clinch River was in and of itself a unique proliferation hazard.

I am trying to get at what was going on in people's minds. Although we do not know who they are, we get positions and statements emanating from various places—the administration, the Department, the Nuclear Regulatory Commission, the White House—and every once in a while they do not make any sense. And this is one that never did make any sense at all, that the breeder at Clinch River constituted a unique proliferation hazard.

I would not argue with you at all. I am certainly well aware of the fact that having the Indians detonate a nuclear weapon, even though it had nothing whatsoever to do with the peaceful use of nuclear energy, confused people. The President himself made the statement that it was done with plutonium produced by nuclear power, which was totally contrary to fact, and people were confused by it.

But why pick out Clinch River?

Mr. Scheinman. Mr. Chairman, I cannot speak to the question of why Clinch River per se was selected out unless you want me to place it in the perspective of how could we proceed to ask other countries to slow down and reassess the situation if we ourselves were not going to slow down and reassess our situation.

Mr. McCormack. I personally talked to him about the fact that conventional nuclear powerplants have produced 500 times as much plutonium as Clinch River. He was not ignorant of that fact, and yet he seemed to be hanging his hat for his opposition to the breeder program on the fact that Clinch River uniquely would constitute a proliferation hazard, and this seemed to have something to do with our going into INFCE.

Then the question of reprocessing came into the picture at the same time.

Dr. **Scheinman.** I think I would reverse the priorities on that point, Mr. Chairman, and note that the production of plutonium contained in spent fuel represented one type of problem. The extraction of that plutonium from the spent fuel and storing it in preparation for use in either mixed oxide fuels or thermal reactors or other purposes represented yet another problem.

It was the question of the reprocessing and storage of the successful and attractive targetable material that could be used for weapons purposes which was at the base.

Mr. **McCormack.** We know that it can be made into an explosive if you are good enough. We know that it is possible, but by every criterion, it is the wrong way to go. It is far more expensive and far more difficult, et cetera. Everything is wrong with it. We all know that.

And we all know that the only fuel that we are talking about here now is, for Clinch River, a few loads. The administration did not object to having the loads for FFTF, which is an identical fuel. Are you suggesting that producing the fuel for Clinch River alone is not OK, but for FFTF it was?

Dr. **Scheinman.** I do not suggest that at all. I actually am trying to suggest that the use of commercial fuel as a source for nuclear explosives is, as you say, an unattractive way to go. It is not the preferred alternative pathway, but certainly it is not a pathway that can be excluded under a variety of circumstances.

Mr. **McCormack.** The President did not say that we were going to stop all nuclear power production. He said we are going to stop Clinch River. You have given us a detailed step-by-step history of what happened in here, but the one thing that is missing is the real rationale.

I am just curious to see if somehow you could perhaps add that. That is why I asked who really suggested INFCE. Who really wanted it?

When I talked to the representatives of all four nations at that time, they regarded it as something of a condescending concession to keep the President happy.

Dr. **Scheinman.** I do not think I am in a position to authoritatively define who it was and who other than the President decided that Clinch River should not be built.

My concerns are much more with the question of reprocessing and the question of plutonium storage and the like. I see the decision not to proceed with the Clinch River reactor as a part of a broader policy or a set of policy concerns with respect to the extraction, storage and use of plutonium, and as part of a period of reflection and reassessment, including how to proceed with breeders.

Mr. **McCormack.** Was there ever any consideration given to coprocessing and handling fuel containing plutonium, not as plutonium so that it can be used for weapons, but always mixed with uranium in nonexplosive ratios?

Dr. Scheinman. As a matter of fact, in negotiating an agreement for limited utilization at Tokaimura, we secured from the Japanese a commitment to undertake at laboratory-scale level some coprocessing R. & D. in order to know whether it might be adaptable to larger scale use at a later point in time.

I do not have at my fingertips the results of that coprocessing experimentation except to know that the decision has not yet been taken to deploy that technology on a larger scale in the Tokaimura plant.

Mr. McCormack. Was there unanimity in the White House family that Clinch River was a threat and that reprocessing, even if we modified it, was a threat? Was there unanimity among the White House advisers that mixed oxide fuels were really a proliferation threat?

Dr. Scheinman. Our Government is not a monolith, as you know, and I am sure that a wide range of views were expressed with respect to the severity of the threat, in the same way that a wide range of views undoubtedly could be elicited today with respect to the degree of concern that one might want to have with respect to one or another aspect of the fuel cycles.

But I would say that there was a very clear and concise agreement with respect to the nature of the threat of proliferation insofar as reprocessing and separation of plutonium was concerned, with most of the emphasis, frankly, in my memory, being on the question of recycling in light water reactors, and avoiding premature commitment to high risk technologies.

Mr. McCormack. OK.

You mentioned that the stimulus for developing international supplies of U238 or of low enriched uranium fuel elements came primarily from the closing of the order books by the Atomic Energy Commission in 1974. If my memory serves me, this is because we felt at that time that we were at maximum capacity for this particular historical period in which we are now living.

The projection was that we would oversell our capacity. Is this correct?

Dr. Scheinman. My memory is slightly different, Mr. Chairman.

[Simultaneous conversation.]

Dr. Scheinman. I believe that the decision to close the order books was, in part, related to the fact that there was an ongoing discussion at that time on how to proceed with the next level of enrichment development, whether it should be a Government enterprise under the contractual relationship between the Government and the companies that ran our fusion plants, or whether alternatively it should be private.

It was in that context that decisions were withheld with respect to the next level of development. And having not decided to proceed at that moment in one direction or another, and having saturated the capability of our plants to produce separative work, it was then decided to open up a system of conditional contracts, on the one hand, and to not take any further contractual commitments, on the other.

Mr. McCormack. What I was getting at was that the reason was not an arbitrary decision but one that was based on the presumption that, as you say, we had saturated our capacity for enrichment, projected capacity for enrichment, at that time.

Do you believe this caused an alienation of the other nations of the world?

Dr. **Scheinman**. Not so much an alienation, Mr. Chairman, as a bit of a shock perhaps that a traditional supplier of 20 years' standing now found itself in a position where it could not offer the same terms, conditions and certainty that had become traditional.

On the other hand, other countries had already decided, even before 1974, to try to open up a little competition with the United States. The Eurodif plant did not actually date the concept from 1974, but preceded it, and the same thing is true with Urenco. The Soviet Union had entered the separative work marketplace several years before that, as well, and these were all signs that diversification could take place and that it might even be healthy for the international nuclear marketplace to have a range of possibilities with respect to the acquisition of low enriched uranium.

Mr. **McCormack**. It turns out they were smarter than we.

Mr. **Wydler**. Mr. Chairman, I just want to comment. Both Dr. Scheinman and the next witness make a great deal about President Ford's role. I do not exactly know why, but I guess it is to try to indicate there is some connection between what he did and what President Carter did, and I do not think there is any. I am going to try to put this in some perspective, if I can.

The Carter policy is the Carter policy, and it should stand or fall, in my judgment, on its merits, whatever they may be. And obviously President Ford did say what you said he said, and I presume you are correct when you say there was a great body of opinion at that time that there was a danger in the air. I would guess by the date of October 28, 1976, which was probably about a week before the election, that he——

[Mr. Wydler confers with staff.]

Mr. **Wydler** [continuing]. That was about a week before the election. They must have gotten word—I presumed what happened was that Carter was going to say something on this issue, and we have to do something to counteract any effect it may have. So we will make a statement on the issue.

I think anybody who has grown up and has been around politics recognizes that for what it is. You do not make major policy statements in the last day of a Presidential campaign unless you have a feeling there is some significant matter about to take place on the other side.

So I would say when I read the statement, it does, in fact, say he has some concerns about the problem and we should look at it very carefully. That is essentially what it says. But I also know that subsequent to this the Ford budget went forward to the Congress, and it had in there both the money for Barnwell and the money for the Clinch River breeder reactor. It was subsequent to the election of President Carter that the decision was made—I think it was in March of that year—it was made in stages.

First he cut down a little bit on the money for Clinch River. Then he indicated he did not want any, or something like that. I cannot remember exactly the history of the thing. At the same time, he was cutting off Barnwell. Neither of those things was suggested by President Ford, and I do not think ever would have happened under President Ford.

I just want to make the point that I think whatever President Carter's policy is, he should be willing to defend it on the merits, whatever the merits may be. That is where he should stand. I do not think he can say that President Ford would have done what he decided to do.

I think it is rather clear from the record, if my memory is correct, that in March, in fact, it was that President Carter decided not to go ahead with the Clinch River project, that it was in early April, a few weeks later, that he decided that we need an INFCE meeting.

And as I said, I think the whole motivation was—it is really obvious from the time—to try to sell the new U.S. policy, which was then a new U.S. policy, President Carter's policy, to the world. He was going to try to sit them down, the countries that had some nuclear technology, and convince them that the U.S. policy was the way to go.

I do not see anything wrong with that, but I think that that is really what a fair reading of the history of those days leads us to believe. And the decisions to not reprocess fuel and to build a breeder reactor were not the decisions of Carter and Ford, but they were the decisions of President Carter.

Whatever good or bad may be said about it, let's take it in that context and stop trying to go back and lean on President Ford and say that he was part of this decision, which I do not think he ever was, and I do not think the record shows that.

Dr. SCHEINMAN. May I respond?

Insofar as the Ford administration is concerned, as to nonproliferation matters, I think the record is very clear that that concern was very deep and abiding, even though, as you properly point out, the decisions were taken very late in the campaign.

The analysis, however, was done several months earlier, in July and early August, when the campaign was in kind of a neophytic stage. The Ford administration had taken the initiatives for the London suppliers group to get multilateral taking up of the nuclear exports of the major supplier countries, and the reprocessing evaluation program to which you referred did not in the time remaining to the Ford administration ever get put into or was never clearly specified exactly what that reprocessing evaluation program would consist of.

It can very fairly be looked upon as a kind of a program which very well could have had many of the characteristics that one found ultimately in the INFCE exercise.

Mr. WYDLER. I am being shown a whole number of statements made by the administration at that time. They indicate pretty clearly a desire to continue with the ongoing programs merely indicating there is a concern with the problem, and we are going to look into it and make sure that we can control it, and so on, which are the general statements that are made.

I do not find them, frankly, inconsistent with what I said, your statement that they started to look into it 2 months before. That is probably about the time they heard that their opponent in the campaign was going to bring this up and make an issue of it, and said let's find out what that is all about.

I am just speculating. I was not there. It sounds so typical of a political campaign that I think that is almost inevitably what happened.

Dr. Scheinman. I think that is a fair speculation, sir.

I think also if you look at the longer term record, it is not inconsistent with the way the Ford administration——

[Simultaneous conversation.]

Mr. Wydler. I am sure there was a concern with nuclear proliferation, and I am not suggesting that he said that only for that reason. But it became highlighted in his mind, and certainly when you make a statement on the 28th day of October and you are about to stand for reelection the next week, there is some reason why you make a new policy statement. Something brought it to the forefront, and it was not any world event.

So it was probably something happening in the campaign. I am just speculating, but the main point I am trying to make is that this is President Carter's policy, and it is either good or bad. You can argue about that. That is a matter of opinion.

Some people have one opinion, and some have another. But I just did not like the attempt, it seemed to me, to make it the Ford-Carter policy, which I do not think it is.

Mr. McCormack. Dr. Scheinman, I want to thank you very much for your testimony. I am not going to hold you any more. As you know, we have to leave for a vote, and I appreciate your testimony today.

Again, we may have questions written for you.

Cornell University,
Ithaca, N.Y., June 5, 1980.

Hon. Mike McCormack,
Chairman, Subcommittee on Energy Research and Production, Committee on Science and Technology, Rayburn House Office Building, U.S. House of Representatives, Washington, D.C.

Dear Mr. Chairman: Regrettably, our exchange of views yesterday had to be cut short due to a second recess in response to a call for a vote on the floor of the House. Consequently, I did not have an opportunity to fully respond to several points being made by yourself and Representative Wydler. I would be very grateful if the following brief, but hopefully helpful response to the CRBR issue could be entered in the record as the closing part of my testimony, just before you had to intervene to terminate the afternoon's proceedings.

Thank you very much for your kind consideration, and for the opportunity to appear before the Subcommittee. If there is any way in which I can be of further assistance please do not hesitate to call upon me. As you note in my closing formal remarks I am deeply concerned about the future of nuclear energy in this country and would like to see a good balance struck.

"The decision not to proceed with CRBR was, of course, a domestic decision. To my memory it was taken by the President in view of several considerations, among them a conviction that the direction of breeder research and development was in need of review, that CRBR was in any event no longer a technically attractive way to proceed, and that during the period of pause covered by INFCE, the U.S. would be able to assess with others preferred alternative RD&D strategies. Additionally, this would be supportive of our overall non-proliferation objectives and fully consistent with their underlying philosophy. I think it very important to separate the CRBR project from the breeder development program and to recognize that the latter remained for many in the Administration a central concern, while the former was not essential at least in the near term. So a distinction was made in our mind between CRBR and breeder R&D, and this, Mr. Chairman, explains, at least in my view, how these matters were related."

Again, thank you for appreciating that some answer to the important questions you raised should be in the record as part of the testimony.

Cordially,

Lawrence Scheinman.

Mr. McCormack. I have a very serious problem here with scheduling and I am very sorry. I could perhaps get back here in 10 minutes and take a 5-minute statement from you, but I have a 6 p.m. meeting off the hill which I must attend.

I wonder if Dr. Cochran would be willing to submit his statement in writing and respond to questions in writing. Would that be acceptable?

Dr. Cochran. Mr. Chairman, I hate to write. I have written my statement. I will be happy to submit it.

Mr. Wydler. The only thing I would suggest to the doctor—I do not know how you feel about it, but couldn't we put him on first thing tomorrow?

Mr. McCormack. We could certainly look at that.

Dr. Cochran. You have a very full agenda tomorrow, and furthermore, I will be in New York. So it may be inconvenient.

I would be happy to submit my statement for the record, and I will take questions in writing.

Mr. McCormack. I did not mean to treat you unfairly. I hope you appreciate that fact.

Dr. Cochran. Well, it has happened before, not in this committee. I am getting used to it.

Mr. McCormack. If it had not been for the vote at this time, we would have you on now, but unfortunately there is no way to get over there and back in less than 10 minutes.

Mr. Wydler. Are we going to have other hearings besides tomorrow?

Mr. McCormack. We have nothing scheduled on INFCE.

Dr. Cochran. The only thing I find unfortunate about this is I would very much like to answer a lot of the questions I have heard you all ask some of the other witnesses, and I think I could give you some insights that you have not heard. I do not relish the thought of doing that in writing.

Mr. McCormack. Would you like to make an additional statement in response to what you have heard today?

Dr. Cochran. No, sir. I would prefer some time, maybe even privately, to just air these issues out with either the two of you or either one of you, and go back through some of this history.

Mr. McCormack. Let us work toward that then, toward getting together at a future time.

I am sorry that we cannot get together tomorrow, and I am sorry that it is almost impossible to continue today.

Dr. Cochran. I will be happy to submit my statement.

Mr. McCormack. We will accept your statement in writing and submit questions in writing and attempt to get you before us for an informal statement in the coming weeks.

[The complete prepared statement plus answers to questions asked of Dr. Cochran is as follows:]

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Testimony of

Thomas B. Cochran

on

U.S. Post-INFCE Nuclear Nonproliferation Policy

before the

Subcommittee on Energy Research and Productic
of the
Committee on Science and Technology
U.S. House of Representatives

June 4, 1980

Recycled Paper

My name is Thomas B. Cochran. I am a Senior Staff Scientist with the Washington, D.C., office of the Natural Resources Defense Council, on whose behalf I am appearing today. I have a Ph.D. in Physics from Vanderbilt University. I was a member of DOE's Ad Hoc INFCE/NASAP Study Group* chaired by Professor Henry Rowen of Stanford University. I am very pleased to have the opportunity to appear before this Committee and present our views with respect to the future direction of U.S. nuclear nonproliferation policy now that the INFCE process has been concluded.

Let me begin by reminding the Committee that both Presidents Ford and Carter have agreed that in developing U.S. policy "nonproliferation objectives must take precedence over economic and energy benefits . . . ." In his nuclear policy statement of October 28, 1976, President Ford Stated:

> I have concluded that the reprocessing and recycling of plutonium should not proceed unless there is sound reason to conclude that the world community can effectively overcome the associated risks of proliferation . . . I have decided that the United States should no longer regard reprocessing of used nuclear fuel to produce plutonium as a necessary and inevitable step in the nuclear fuel cycle, and that we should pursue reprocessing and recycling in the future only if they are found to be consistent with our international objectives.

President Carter, on April 7, 1977, when the INFCE process was proposed, stated:

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*/ International Nuclear Fuel Cycle Evaluation/Nonproliferation Alternative Systems Assessment Program

best copy available

> The U.S. is deeply concerned about the consequences for all nations of a further spread of nuclear weapons or explosive capacilities. We believe that these risks would be vastly increased by the further spread of sensitive technologies which entail direct access to plutonium, highly enriched uranium and other weapons usable material.

As recent events in Pakistan, Iraq, India, and South Africa have demonstrated, this is an equal if not greater concern today.

We must not lose sight of this primary objective: curtailing the spread of sensitive technologies and weapons usable material. Stated in different terms, a primary objective of U.S. nonproliferation policy must be to assure timely warning of a diversion of peaceful nuclear materials and technology to the manufacture of atomic weapons. Timely warning is essential to the viability of any international safeguards regime and, under the Nuclear Nonproliferation Act of 1978, must be given "foremost consideration."

Many nuclear industry spokesmen and some Members of Congress would have us set aside our concerns and this objective, and reopen the GESMO*process with the hope of making plutonium recycle in thermal reactors a legitimate commercial enterprise.

Others, primarily some Administration officials, are willing to compromise this objective -- curtailing the spread of sensitive technology -- for the sake of "easing tensions

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*/ Generic Environmental Statement on the Use of Mixed Oxide Fuel in Light Water Reactors.

with our allies," or "removing diplomatic irritants." This backpedalling has already begun with the Administration's announcement of willingness to continue to supply nuclear fuel to India, a country that has exploded an atomic bomb, refuses to sign the NPT or accept international inspection of all its "civilian" fuel facilities, and refuses to rule out further "peaceful" nuclear explosions.

Clearly, "easing tensions" is not an end in itself; it is another way of saying that a policy based on consensus is generally to be preferred over a policy based on leverage. While we agree in principle, we disagree with those who use the principle to justify backpedalling.

Both those who wish to reopen the GESMO process and those who say that we must "ease tensions" argue that the U.S. took its best shot in INFCE and lost in its effort to delay the commercial development of the breeder; that the Europeans and the Japanese are going ahead; and that U.S. policy must be revised to accommodate this reality.

This argument is flawed in every respect. In fact:

(a) INFCE was highly politicized. Many of the INFCE findings, particularly those related to nuclear growth projection, uranium supplies, and the potential of breeders (i.e., rate of commercial introduction, breeding ratio, economics, etc.) are ridiculous on their face. Interdevelopment, Inc., of Arlington, a U.S. industrial consulting firm, for example, projects 480 Gw of installed nuclear capacity in the non-Communist world in the year 2000, which is barely over one-half of the INFCE low-case estimate of 850 Gw (Nucleonics Week, May 22, 1980, p. 1).

(b) The U.S. did not take its best shot. The U.S. representative on INFCE's Breeder Working Group was the director of the U.S. breeder effort, an unabashed enthusiast for this technology. The U.S. failed to maintain adequate political control over representatives of this and some other key working groups. With no one minding the store, it is hard to take seriously the INFCE results in this area.

(c) The European and Japanese breeder efforts are on the verge of collapse. The entire FRG nuclear program, like the U.S. program, is at a standstill. The Kalkar reactor squeaked by the Bundestag by a slim margin. The German Government is keeping an "open mind" on the breeder and would gladly give it up altogether in exchange for moving ahead with LWRs. Despite the rhetoric of the Thatcher Government, the U.K. cannot justify launching a PWR program, much less breeders. The U.K. has something like a 40% excess reserve margin and is facing no growth in electrical demand. The Japanese just slipped their breeder program ten years or longer, due to "long range R&D delays and mounting costs." The French now have a "commercial" breeder than cost 2.4 times the cost of a PWR -- another Concorde. Dissent within the French Government over the rate of expansion of the French breeder program is beginning to have its effect.

(d) Not only are nuclear growth projections down worldwide, but also uranium reserves are expanding and uranium prices have been falling in real terms for the past two years. On the world market, there is excess capacity; it's a buyer's market; and the uranium industry is in the midst of a depression.

Thus, we see that the foreign breeder programs are in the same state that plutonium recycle was in in the U.S. in 1976. While there is no shortage of rhetoric, the reality is that the plutonium industry is collapsing. The INFCE findings reflect the breeder boosterism, and the backpedallers within the Administration are responding to their rhetoric. They should be responding instead to the realities and the very real prolifreation threat. With regard to the latter, the only nuclear programs that are expanding beyond expectations are the nuclear weapons programs in the Middle East and East Asia -- Pakistan and Iraq.

The reality of the collapse of the plutonium industry inevitably must be considered by policymakers in Europe and Japan, nor can it be easily dismissed as they continue to reassess their own breeder commitments. The U.S. should not soften its resolve at the very time that events are shifting in our favor. If we do, we will lock ourselves into a policy that legitimizes commercial or R&D use of weapons usable materials.

One nonproliferation alternative that has been proposed as a means of limiting the spread of sensitive technology and the flow of weapons usable material is to draw the line between high technology countries with large electric grids and large nuclear programs on the one hand and developing countries on the other for purposes of limiting breeder development. This would allow our non-nuclear weapons state allies -- Japan and the Federal Republic of Germany -- to continue unencumbered with their own breeder programs while enabling the U.S. and its industrial allies to constrain breeder development in other non-nuclear weapons countries. Aside from the fact that this would be a blatantly discriminatory policy, we do not believe a workable distinction can be made. If Japan meets the test, then so does Korea; if Korea, then Brazil; and so on. Furthermore, it pretends that smaller countries have no legitimate business in developing an industry solely for the export market.

The choice before us is not between "leverage" and "consensus;" rather, it is between sticking to our principles and abandoning them. At the time the April 1977 policy was formulated, the Administration concluded correctly that the most immediate threat was represented by reprocessing and plutonium recycle in thermal reactors. The breeder was limited primarily to a few countries with good nonproliferation credentials. Because of the breeder's "energy independence" appeal (actually a false hope) and its nature as a long-term

R&D program, the Administration concluded that it would be much more difficult to convince countries with breeder programs to give up this technology. Thus, in developing its nonproliferation strategy, the Administration attempted to draw a distinction between "commercial" plutonium recycle in thermal reactors and "commercial" breeders on the one hand, and breeder R&D on the other -- the objective being to defer commercial use of plutonium but permit breeder R&D to continue. Some people apparently have forgotten that this was a "tactical" distinction, and that in reality the breeder fuel cycle, even as an R&D program, is actually less proliferation-resistant than plutonium recycle in thermal reactors (cf. the NASAP results).

The Administration's nonproliferation policy has met with considerable success in deflecting the rush to recycle plutonium in thermal reactors, its first goal. A large measure of this success was due to the realization worldwide that plutonium recycle was uneconomic and not necessary for waste management. The response of the advocates of reprocessing has been simply to shift their rationale, arguing that reprocessing was now needed for the breeder, not for thermal recycle. It is now becoming clear worldwide that the breeder is facing the same fate.

We are now faced with a struggle that is half over. Having won the first half, we are amazed at how quickly some in the Administration are willing to throw in the towel. We can win the remaining battle by continuing to hold the line, by employing the tactics we used with respect to plutonium recycle. Thus, in shaping our post-INFCE nonproliferation policy, we should not compromise away our gains. We should not abandon the concept of timely warning. We should not make significant concessions, and should close major loopholes. Our objective should be to make it harder to reprocess, harder to expand breeder technology, not easier.

It follows that one goal should be to persuade our allies to defer or abandon the expansion of La Hague and the construction of the Thorp facility at Windscale and the new commercial reprocessing plant in Japan. These new starts are not needed to insure fuel for the currently committed breeder demonstration projects in Japan and FRG during the next 10-15 years at least.

While we should oppose new breeder starts, this is not an immediate problem. With regard to retransfers and exports for breeder R&D, we should require a demonstration that the timely warning criterion is met, or that: (a) the program is directed toward achieving that goal in the future; (b) no shipments are made in advance of actual need; and (c) the most proliferation-resistant technology and approaches are utilized.

With regard to requests for retransfers of spent fuel (MB-10s), we should continue to require for contracts that post-date April 7, 1977, a clear showing of need: that is, either a lack of spent fuel storage sapce or a showing that the plutonium is needed for currently committed breeder demonstration facilities. We should insure that plutonium cannot otherwise be obtained from existing stocks and insist that reprocessing does not take place far in advance of the need for plutonium.

With regard to pre-existing contracts, we do not recommend changing the existing policy except to set out the criteria for subsequent transfers of the plutonium at the time of the initial transfer. We should not approve an contracts for reprocessing in new or expanded reprocessing plants unless and until it is clear that existing capacity no longer matches projected breeder R&D demands.

We should not approve of reprocessing or retransfers for the commercial use of plutonium -- e.g., plutonium recycle in thermal reactors, or "commercial" breedres. If the French find this policy an irritant, so be it.

Regarding the international plutonium storage regime (IPS), we do not believe such a regime can be constructed in a way that meets the timely warning criteria under rules agreeable to the Europeans and the Japanese. As in the INFCE process, the rules would reflect the lowest common denominator and we would end up with something much weaker than we could achieve through bilaterial agreements. IPS would legitimize large stocks and flows of plutonium, contrary to the Administration's desire to limit these, and it would result in strong pressure to recycle plutonium in thermal reactors once the stocks become available.

As for long-term fuel supply contracts, we see little purpose served by giving away future leverage unless we receive new and very important concessions in return. After Tarapur, we are surprised anyone would seriously suggest this simply as a method of promoting cooperation.

We hope these views are useful to the Committee in its struggles with this very difficult issue.

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
[illegible]
WASHINGTON, D.C. 20515

June 10, 1980

Dr. Thomas Cochran
Natural Resources Defense Council
1725 I Street, N.W.
Suite 600
Washington, D. C. 20006

Dear Dr. Cochran:

It was very unfortunate that, because of unforeseen circumstances, you were prevented from testifying before the Subcommittee on Energy Research and Production on June 4. I apologize for the imposition on your time. Although we failed to have sufficient time for your remarks, I have read your prepared statement and found it to be particularly useful.

After the hearing, you indicated that you would provide the Subcommittee with additional information in response to further questions on your testimony. I appreciate your willingness to work with us further on this matter. We would appreciate your providing, for the record, responses to the enclosed questions. Since we were unable to discuss your testimony at the hearing, your responses are especially important for the record.

Your prompt reply would be most appreciated. Thank you for your cooperation on this matter, and please accept my sincere apologies.

Sincerely,

MIKE McCORMACK, Chairman
Subcommittee on Energy
Research and Production

MM/Cwm

Enclosure

NATURAL RESOURCES DEFENSE COUNCIL, INC.,
Washington, D.C., June 27, 1980.

MIKE MCCORMACK,
Chairman, Subcommittee on Energy Research and Production, Committee on
Science and Technology, Rayburn House Office Building, Washington, D.C.

DEAR CONGRESSMAN MCCORMACK: This is in response to your letter of June 10, 1980, enclosing a list of nine questions addressed to me following the hearings before your subcommittee on June 4, 1980. Enclosed you will find responses to these questions. Please include this with my prepared statement as part of the formal hearing record.

If I can be of any further assistance, please let me hear from you.

Sincerely,

THOMAS B. COCHRAN.

Enclosure.

RESPONSES TO QUESTIONS FOR THOMAS B. COCHRAN, NRDC

Question. You indicate proliferation concerns involving Pakistan, Iraq, India, and South Africa. Could you explain how these proliferation concerns appear to be related to the civil nuclear power programs of these nations, particularly those assisted by others?

Response. As indicated by numerous press reports, Pakistan publicly justifies its enrichment and reprocessing plant programs as civil activities "designed for purely peaceful purposes." (Reference 1). This is difficult to reconcile with Pakistan's efforts to construct a weapons test site (Reference 2) and other evidence of Pakistan's military intentions.

The chief indigenous source of plutonium for Pakistan's nuclear weapons program is a "civil" reactor, a 137-Mw Candu nuclear power reactor purchased from Canada in the early 1960s for the purpose of supplying electricity for Karachi. Pakistan also has a 5-Mw (thermal) research reactor, but it doesn't produce significance quantities of plutonium. (Canada, incidentally, previously supplied the CIRUS reactor, a Candu, to India, which was the source of the plutonium for the Indian bomb.) Pakistan is also trying to get additional reactors, ostensibly for civil purposes.

The source of uranium for Pakistan's weapons programs is the Arlit and Arkouta mines in Niger. The uranium is being purchased by Libya and then reshipped to Pakistan. These mines in Niger are co-owned by the Niger Government and Cogema, a civil nuclear company in France. The Niger Government insists that everything is being done under existing law, and the French are insisting that they have no control over this transfer of uranium, as it meets all legal requirements under the civil reactor program. (Reference 3.)

It is well known that the plans for the Pakistani gas centrifuge enrichment plant were stolen by Abdul Qadar Khan from a civil enrichment plant being jointly constructed at Almelo, Holland, by the British, Dutch, and Germans (Reference 4). President Zia of Pakistan has publicly stated that Pakistan's uranium enrichment program is designed to produce fuel for new light water reactors (see Reference 1).

Perhaps the best unclassified analysis of Pakistan's efforts to obtain nuclear weapons is given in "The Birth of the Islamic Bomb," a BBC film aired in London on June 15, 1980. This film provides perhaps the best unclassified analysis of Pakistan's ongoing efforts to complete its large plutonium reprocessing plant with French, Swiss, and Italian assistance. It also indicates Pakistan has sought several smaller, pilot facilities and secured one pilot plant, the Pinstech facility from a Belgium firm. A 1979 GAO study reported that, under the "Atoms for Peace" program, the U.S. trained at least 135 Pakistani nuclear scientists.

Clearly, the cover for the Pakistani nuclear weapons program and the continued assistance in its development by Niger, Libya, France, Italy, and Switzerland is that the entire effort is a civil activity. Pakistan could never have pulled this off if there were a clear distinction between what constitutes safe, civil activities limited to the use of low-enriched uranium and the more dangerous, weapons-related activities involving plutonium reprocessing and recycle.

INDIA

It is well known that India's nuclear weapons program has, from the beginning, been justified as a civil program, and India even suggests that its weapon test was a test of a "peaceful nuclear device." The plutonium for the Indian weapon was obtained from its CIRUS reactor, a "civil" Candu research reactor supplied by the Canadians. Heavy water for this reactor was supplied by the U.S. The Tronbay reprocessing plant was established as part of India's civil breeder program. According to the GAO study, under the "Atoms for Peace" program, the U.S. trained some 1367 Indian nuclear scientists in every aspect of their nuclear program, nuclear physics, reactor operation, fuel handling, and reprocessing and safety.

IRAQ

Iraq is a member of NPT and therefore has forsworn the development of nuclear weapons. Iraq has purchased 80 Mw (thermal) research reactor, Osiris, from the French (ordered in 1976) but has refused to allow the French to convert the uranium fuel from high-enriched weapons grade to a lower enrichment level. Iraq has ordered fuel handling equipment, a hot cell, from the Italians (Reference 5). Thus, it appears that Iraq is in the process of building the back end of the fuel cycle before they build the front end, or before they have any power reactors. It may be of interest to note here that the Subcommittee on Energy Research and Production recently cut DOE's budget request for the program, Reduced Enrichment for Research and Test Reactors, on the basis of the preposterous claim that these test reactors are "not generally considered to be major proliferation threats." (Cf., p. 66 of your May 16, 1980, publication of the Hearings on the Authorizing Appropriations for DOE for fiscal year 1981.)

As with Pakistan and India, what is lacking for control of the Iraqi program is a clear distinction between what is solely a civil nuclear power activity and a military program. Such a distinction could be drawn between low-enriched uranium technologies and the more proliferation-risky technologies involving weapons-usable materials (high-enriched uranium and plutonium).

SOUTH AFRICA

The public documentation of South Africa's initial efforts to test an explosive fission device is extensive. The test was canceled, or postponed, when preparations for the test were discovered by USSR and U.S. satellite surveillance. Whether in fact South Africa has tested a device more recently is still debated. Here I am referring to the event recorded by the Vela satellite over the large area encompassing South Africa and the South Atlantic and Indian Oceans in September 1979. I have reason to believe the CIA position is that the available evidence supports the view that a nuclear explosion did take place.

South Africa's weapons program is an indigenous one. South African uranium is enriched in the UCOR plant at Valindaba which is ostensibly for civil purposes, namely to provide enriched uranium for South African power reactors and for export. The enrichment technology used by South Africa is based on the aerodynamic (nozzle) concept and its development was assisted by the Germans, presumably again for civil purposes.

Question. You indicate that the U.S. ". . . did not maintain adequate political control" over its INFCE representatives. Given the "ground rules" for INFCE set out in the Washington Communique of the INFCE Organizing Conference, do you believe that it would have been appropriate for us to have attempted to exert such control?

Response. I assume the reference to the Washington Communique of the INFCE Organizing Conference is to the section that states that "participants agreed that INFCE was to be a technical and analytical study and not a negotiation." My reference to the failure to maintain adequate political control over our INFCE representatives was not meant to imply that this was a negotiation, although it was, nor that we should have gagged our representatives. The point is the U.S. should have presented the analytical case that led the Administration to the policy that was announced by President Carter on April 7, 1977, to defer commercialization of reprocessing and the breeder. That case was based on economic, resource, and nonproliferation considerations. We did not present that analytical case, nor did we see it through so that it could be stacked up against the case of those that were proposing that the world should march ahead with a plutonium economy at this time. Instead, we turned over control of the critical working groups to ardent breeder proponents without insuring that our case was presented, and thus failed to insure that the working groups were provided with an accurate and adequate data base. As stated in my prepared remarks, the nuclear growth projections in the data base were preposterous. There was also a failure to include in the projections uranium resources costing more than $50/pound. (The INFCE study recognizes that such resources exist, and, as the NASAP study indicated, these postpone the date when the breeder will become competitive.) There was total saffling on discussion of the relative proliferation resistance of various fuel cycles. There was no recognition of the implications of the substantial economic penalties of the breeder. There was a lack of discussion of the energy security benefits of deferring the breeder technology. The gaseous effluent from reprocessing plants was omitted from the quantitative comparison of the waste management implications of various fuel cycles. There was no discussion of the benefits of simply deferring the technology.

In short, it would have been appropriate for us to have attempted to exert control over the U.S. working group representatives to insure that the data base was both adequate and accurate, and to insure that the analytical case that was before this Administration when it shifted its policy in 1977 would have also been presented and stacked up against the case of the breeder and plutonium proponents.

Question. You state that "The European and Japanese breeder efforts are on the verge of collapse." While there have been some delays in certain of these programs (primarily from reduced electrical growth), I find it hard to reconcile this sweeping statement with, for example, the recent provisional decision of the French utility, EDF, to make a final decision on the construction of two 1,500 MWe Super Phoenix "Mark II" breeders by about 1984, with the first unit to be in operation by about 1990. Please provide any information you have which supports this view.

Response. The French breeder program is recognized as the strongest of the OECD breeder programs. Yet even here the pace of the breeder development is slowing. You attribute this to reduced electric growth. I know of no evidence for this. The French are still expanding their PWR program with which the LMFBR must compete. The French were planning to commit to the two 1,500 MWe Super Phoenix "Mark II" breeders in early 1980, but, as you noted in the question, they have slipped this date to the 1983–1985 period. This slippage is not due to reduced electric growth, but to the fact that the French breeders are costing more than twice as much as a PWR. The French recognize that they can have five PWRs for the cost of two breeders.

The Japanese breeder program has not only slipped ten years, but the government has lowered the industry share for the next machine from 50 to 20 percent, further evidence of the detriorating economic position of breeders.

The U.K. has now decided to postpone a decision on its follow-on breeder until 1985.

As discussed in answer to the next question, the FRG's Parliament Enquete Committee voted recently 9 to 6 to complete the 300 Mw Kalkar demonstration plant but to postpone the decision on whether it will operate.

These actions are hardly what could be described as postponements reflecting reduced electric growth, although in the U.K. case this is certainly one factor.

Question. You state that we have "won the first half" of the struggle. Specifically, what have either of the major supplier nations or the nuclear Less Developed Countries done over the past few years which convinces you of this?

Response. First, the Federal Republic of Germany (FRG) has shelved plutonium recycle, for the time being. The FRG has scrapped the proposal to build a large, commercial reprocessing plant at Gorleben. Following the Gorleben hearings last year, Prime Minister Ernest Albrecht, the Governor of Lower Saxony, decided that the construction of the Gorleben plant was not politically feasible and has since promised that there will be no nuclear waste processing installation built at Gorleben.

At the Federal level, the decision on reprocessing in the FRG is still being shaken out. According to Nucleonics Week, June 26 ,1980, a majority of members of the German Parliament Enquete Committee for the Future of Nuclear Energy voted to accept compromise proposals related to the reprocessing and breeder issues. The reprocessing compromise accepted by 12 of the 15 members proposes an interim period with a two-pronged approach: construction of a reprocessing demonstration plant for testing the technology accompanied by development of technology for disposal of the reprocessed fuel elements. The Committee did not specify the size of proposed reprocessing demonstration plant at Karlsruhe but said it should not be of commercial size.

Germany has had a de facto nuclear moratorium since 1975 with no new reactor starts or licensing. While the Germans have moved away from commercial plutonium recycle, they have not given up totally on breeder development. The same Parliament Committee mentioned above accepted a breeder compromise by a 9 to 6 majority which called for completion of the 300 megawatt fast breeder at Kalkar, but the decision on whether or not it should be put in operation has been shelved for the time being.

Neither the British nor the French have any plans for the recycling of plutonium in light water reactors. The reprocessing efforts in both of these countries—including the reprocessing now going on at La Hague in France and the proposal to build the Thorp facility at Windscale in the U.K.—are based on the assumption that the plutonium will be used in breeders and not in light water reactors. Only Japan and Argentina (and possibly South Korea) are still seriously talking about plutonium recycle in light water reactors. Japan, however, is presently sending its spent fuel to Windscale and Cogema's La Hague plant in France. The Japanese contract with Cogema gives France control over whether or not the plutonium will ever be returned to Japan. In effect, Japan has given up its rights to control the plutonium. It is hard to understand why Japan would enter into such a contract if they were clearly committed to recycling the plutonium in Japanese reactors.

The INFCE Summary Volume recognizes that, if plutonium is recycled in light water reactors, economic advantages are not likely to be large and that reprocessing is not necessary for waste disposal. These statements supported by all the INFCE participants stand in stark contrast to the positions taken only three years ago, for example, at the Persepolis meeting.

Question. You indicate that a U.S. goal should be to delay or kill the expansion of La Hague and construction of the British Thorp and Japanese reprocessing facilities. If you were in charge of carrying out such a U.S. program, how would you devise a strategy to accomplish this goal?

Response. I would make it clear in our bilateral discussions with the French, British, and Japanese that the expanison of La Hague and the construction of new facilities is not needed at this time for their breeder R&D programs, and that we are strongly opposed to these new starts. These new facilities will require spent fuel of U.S. origin. Consequently, I would include as part of our post-INFCE policy nonproliferation criteria along the following lines: First, with regard to requests for retransfers (MB-10s) of spent fuel for purposes of reprocessing, while I would not change the existing U.S. policy regarding contracts that predate April 7, 1977, approvals for new contracts would be granted only where there is a clear showing of need based on inadequate spent fuel storage capacity, or a clear evidence that plutonium is needed to fuel existing research and demonstration reactors. Furthermore, the reprocessing and recovery of plutonium for these reactors must not take place well in advance of the time the plutonium is needed. Spent fuel transfers for the purpose of reprocessing at new reprocessing plants or at expanded facilities would not be granted if existing facilities are available to meet global needs for advanced reactor R&D, except where the processing in a new facility is clearly more proliferation-resistant than available existing faciliites.

Question. You indicate that we should not approve reprocessing or retransfers for use in "commercial" breeders. You then state "If the French find this policy an irritant, so be it." Recognizing that the cooperation of major supplier nations is vital to an effective global non-proliferation policy, do you believe that the attitude you have suggested we take toward France would be conducive toward obtaining their cooperation in such a non-proliferation policy? (You might recall that France probably possesses the most advanced reprocessing technology and that its cooperation was essential in negotiating cancellation of the Korean and Pakistan reprocessing plants.)

Response. The point is that it is more important to have a strong, coherent nonproliferation policy and maintain our resolve to see it through than it is to negotiate our principles away in order to achieve a consensus. Nonproliferation is in the French interest. Even if they do not go along with every aspect of U.S. policy, France would surely continue to cooperate where it finds it to be in its own interest. But where there are disagreements between the U.S. and France on nonproliferation policy, we shouldn't abandon our own principles simply to achieve consensus with the French.

Negotiation of cancellation of the Korean and Pakistani reprocessing plants is an example where it was agreed that this was in the mutual interest of both France and the U.S. The French nuclear industry, however, is still giving assistance to Pakistan in its efforts to develop the reprocessing technology for its weapons program (Cf BBC film discussed in response to Question 1). Surely we should not join the French in this activity simply to achieve consensus.

Question. You question, apparently without having any details of the plan, whether International Plutonium Storage can be constructed in a way which will meet the "timely warning" criterion and still be acceptable to other nations. Without agreeing with that conclusion, even if it ultimately were to prove correct, would it be a worthwhile trade-off to accept a somewhat less rigorous criterion on U.S.-controlled plutonium if in so doing we were able to bring large quantities of plutonium over which we currently have no control under substantially higher levels of safeguards, physical security and controlled use?

Response. The International Plutonium Storage regime was never offered as a means of meeting the "timely warning" criterion. If there were a clear and easy way to achieve "timely warning" with IPS, it would have been seriously considered long before now.

With regard to the second part of the question, the argument being made is similar to that used in the 18th century in defense of the slave trade, about half of which was conducted by British merchants. In the debates in Parliament, it was argued that the British could not abolish the slave trade, they could only relinquish it to the Spanish and the Dutch, and the British should stay in the trade to insure the humane treatment of the slaves. Should we stay in the commercial plutonium business "to ensure control over plutonium?" No. The U.S. should continue to press for more rigorous control over plutonium, particularly the plutonium that is already separated and in a weapons-usable form. However, we should not accept an ineffective international regime simply to bring larger quantities of plutonium under its control. Frequently, the best leverage is to withdraw or withhold approval and condemn an ineffective policy, rather than give it legitimacy by joining in its implementation.

Queston. What interpretation do you place on INFCE's failure to compare and rate proliferation risks of various nuclear fuel cycles?

Response. See response to Question 2, the discussion of failure to maintain adequate political control over our INFCE representatives. In addition, the failure to compare and rate proliferation risks of various fuel cycles also derives from a feeling on the part of certain U.S. State Department officials that it would appear offensive to draw out the enormous differences in the proliferation risks between the breeder and the once-through fuel cycle system.

Question. What is your assessment of these risks? Why?

Response. It would be difficult to give an exhaustive account here. However, I agree with the general summary conclusion of the NASAP study. The most important conclusion of the NASAP proliferation resistance assessment was:

1. All nuclear fuel cycles would entail some proliferation risk; there is no technical "fix." Nevertheless, the light water reactor fuel cycle with spent fuel discharged to interim storage does not involve weapons-usable material in any part of the fuel cycle and is a more proliferation-resistant nuclear fuel cycle than other fuel cycles which involve highly-enriched uranium or plutonium.

2. There would also be substantial differences in proliferation resistance among the fuel cycles if they were to be deployed in non-nuclear weapons states.

3. Technical and institutional proliferation-resistance features can help.

4. The vulnerability to threats by subnational groups varies among fuel cycles. Recycle systems would be vulnerable to a wide range of threats, whereas current once-through fuel cycles are susceptible to only the most sophisticated threats.

Question. Assuming nuclear power will continue for the next few decades, what proliferation risks do you see in the once through fuel cycles with perpetual spent fuel storage?

Response. The proliferation risks associated with the once-through fuel cycle have been identified in the NASAP report. Some of the more important concerns relate to: (a) the risks associated with the Candu reactor fuel cycle, namely the Candu's capability for on-line refueling and its attractiveness because it does not require an enrichment technology; and (b) the risks associated with the light water reactor cycle mainly the enrichment facility which can be modified to produce weapons-usable materials.

Although plutonium is produced in once-through fuel cycles and will be contained in the spent fuel, the highly radioactive fission products make reprocessing a more difficult chemical operation. To separate the plutonium from the fission products would require the same reprocessing operation technology during the first 100–150 years of storage. Assuming that the spent fuel is disposed of in a deep geologic repository sometime during this 100–150 years, the proliferation risks associated with the future plutonium "mines" would be less, I believe, than the proliferation risks associated with the plutonium "rivers" that would be apparent in any of the recycle fuel cycle options. At least it should be easier to meet the "timely warning" criterion.

Question. Where do you think spent nuclear fuel should be stored? Under what conditions?

Response. Spent fuel should be stored in a deep geologic repository in a nonretrievable manner.

References[*]

1. New York Times, April 9, 1979 A–1, 9; "Pakistan Denies It Plans to Develop Nuclear Weapon." New York Times, August 28, 1979 A–16; "Pakistan Wants No Nuclear Weapons." New York Times, September 23, 1979 A–14; "Zia Denies Pakistan Builds Nuclear Bomb and Urges U.S. to Resume Aid." State Department Telegram to Brussels Embassy, January 14, 1980; "Press Reports on Pakistani Proposal to India on Nuclear Inspection."
2. New York Times, August 17, 1979 A–6; "U.S. Aides Say Pakistan Is Reported To Be Building an A-Bomb Site."
3. State Department Telegram to Paris Embassy, January 14, 1980; "Press Reports of Diversion of Niger's Uranium Exports." State Department Telegram to Secretary of State, January 14, 1980; "Niger Govt. Denies Diversion of Uranium Shipments to Libya and Pakistan." State Department Telegram to Niamey Embassy, January 14, 1980; "Exports of Niger Uranium." State Department Telegram to New Delhi Embassy, January 14, 1980; "Exports of Niger Uranium." State Department Telegram to Secretary of State, January 14, 1980; "Exports of Niger Uranium." State Department Telegram to Secretary of State, January 14, 1980; "(LOU) Niger's Uranium Sales."
4. Washington Post, August 27, 1979 A–1, 22; "Pakistan: The Quest for Atomic Bomb."
5. New York Times, March 17, 1979 A–1, 8; "Iraq Said To Get A-Bomb Ability With Italy's Aid."

Mr. McCormack. This hearing will adjourn until 9:30 a.m. in this room.

[Whereupon, at 5:20 p.m., the subcommittee adjourned, to reconvene at 9:30 a.m., June 5, 1980, in the same place.]

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[*] These references were included in response as enclosures but because of their volume they have been referenced here.

NEW DIRECTIONS FOR NUCLEAR R.D. & D., POST-INFCE

THURSDAY, JUNE 5, 1980

U.S. House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, D.C.

The subcommittee met at 9:45 a.m., in room 2318, Rayburn House Office Building, Hon. Mike McCormack (chairman of the subcommittee), presiding.

Mr. McCormack. The meeting will come to order, please.

Ladies and gentlemen, this morning the Subcommittee on Energy Research and Production continues hearings that were begun yesterday on the international nuclear fuel cycle evaluation, known as INFCE. We heard from a number of distinguished witnesses yesterday and we have a number of distinguished witnesses to be before us today, so we will move directly to the witnesses.

Our first witness today is Dr. Chauncey Starr, vice chairman of the Electric Power Research Institute. He has appeared before this subcommittee on several previous occasions. He always brings with him interesting and exciting testimony. We welcome you here this morning, Chauncey. We welcome him and consider his views invaluable in deliberation of this subcommittee on nuclear power matters. Dr. Starr, if you are ready, you may make your presentation at this time. We have your testimony before us which, without objection, will be inserted in its entirety in the record at this point, and you may proceed as you wish.

[The biographical sketch of Dr. Starr follows:]

Dr. Chauncey Starr

Chauncey Starr is an internationally recognized leader and pioneer in the development of atomic power. He is now Vice Chairman of the Electric Power Research Institute (EPRI) following five years of service as its founding president. From 1966 to 1973 he was the dean of the UCLA School of Engineering and Applied Science, after a 20-year industrial career, during which he served as vice president of Rockwell International and as first president of its Atomic International Division.

He became associated with the Manhattan District in its early days at the Radiation Laboratory, University of California at Berkeley, and subsequently at Oak Ridge. Following World War II, he pioneered in the development of nuclear propulsion for rockets and ramjets, in miniaturizing nuclear reactors for space, and in developing atomic power electricity plants. Under Starr's direction, Atomics International pioneered nuclear power in space with the flight of the Space Nuclear Auxiliary Power (SNAP) reactor system and the development and demonstration of two major nuclear reactor concepts—the organic-cooled reactor and the sodium-cooled reactor. The latter pioneered the large-scale sodium systems which are used in the fast breeder reactor programs worldwide. The test facilities built for that early development now form the largest liquid sodium development center in the United States.

Chauncey Starr has been generally perceived by his colleagues as a combination of scholar, engineer, manager, and entrepreneur. Perhaps his most unique achievement combining these talents has been his development of the Electric Power Research Institute. Starting with a charter from the electric utility industry to establish a center for advanced technology development, Starr has succeeded in creating an internationally known technical institution that comprehensively addresses all aspects of electricity generation and distribution, including nuclear power. EPRI has established working relationships with the nuclear and electricity development centers of all other industrial countries. When the unfortunate Three Mile Island accident occurred, EPRI immediately became the focal point for the utilities' technical response to this emergency through the establishment of the Nuclear Safety Analysis Center (NSAC).

As a personal effort, Dr. Starr was asked by the industry to undertake the conception, organizational plan, and selection of senior management for an Institute of Nuclear Power Operations (INPO), which is now a permanently established institution for the training of nuclear plant operators and the maintenance of high standards of nuclear plant operations.

As a participant in the development of national and international policies relating to nuclear power, Starr has been recognized as an outstanding contributor to the understanding of the technological issues. He is a frequent and authoritative witness at congressional hearings and with government agencies. During the past years he has been actively presenting the technical factors and options related to the control of nuclear weapons proliferation, and has collaborated with others internationally in suggesting technical means for mitigating this problem.

STATEMENT OF DR. CHAUNCEY STARR, VICE CHAIRMAN, ELECTRIC POWER RESEARCH INSTITUTE

Dr. STARR. Thank you, Mr. Chairman. I would like to accept your invitation to let the testimony go into the record.

I have had an opportunity to look at some of the comments you have had by previous witnesses, and some of this is redundant, so I will skip the things that have been brought to the committee's attention before. Let me just then summarize quickly the main points which I think the committee might want to consider.

There have always been statesmanlike objectives in U.S. foreign policy related to preventing the spread of nuclear weapons, which go back a long way. One objective was to buy time for establishing international diplomatic control of nuclear weapons. We have had various occasions when we have had a lot of time and have not taken advantage of this opportunity. I think that is something the committee might want to consider. It is not enough to just buy time unless you do something with it.

The second objective of U.S. policy was to establish international institutions for controlling nuclear weapons, and we have done very little in that regard. You are going to hear, I think, from some of the experts in this field this afternoon, so I will not go into the political detail of that history. But that policy is one which I certainly affirm as a major national objective, and one which we have to maintain as a priority goal.

Our second objective nationally, of course, is to develop our energy resources, and there's absolutely no question in my mind that nuclear power is an essential part. You know that there are people in the

United States—and very vocal groups—that do not believe that nuclear power is necessary for our energy mix. I think they are factually and pragmatically incorrect. But that is a matter of professional opinion.

I would like to come to the crux of the situation. I feel that what this administration has done in the past few years has been completely counterproductive to these objectives. In fact, if they had been designed to weaken the United States both domestically and internationally, they could not have been better implemented. I recognize that the administration has stated its good intentions many times about both nuclear power and nuclear weapons, but it is my professional opinion that this administration's initial position with regard to the whole program, and the foreign policy which it represented was based on ignorance and political romanticism, a complete lack of understanding of the realities both of the technical side and of the international political side of the nuclear business.

It is unfortunate that the policies appear to have come from such naive origins. Now, it is not as though the administration did not have that information in its hands at the time the policy was instituted. I have included as part of the testimony a report which was requested by the President back in March 1977, which was submitted to the President at his request on April 6, 1977, prior to the enunciation of his policy by Bob Frye and Bob Thorn, then of ERDA, which studied all of the issues that were supposed to be involved and reexamined in the INFCE program.

The summary of that report is attached to the testimony. It states just what the situation was and what was likely to come out of INFCE. And, in fact, it told the administration in advance what the technical issues are. That is not the first time that the administration has had this kind of information.

Let me just remind the committee that the sense of history in this area seems to be completely lacking in our present policies. I want to recall for you the Baruch proposal which was made in 1946 for the international management of atomic weapons. I was on the technical committee organized by General Groves in 1946, in support of the Acheson-Lilienthal report which formed the basis of that proposal. This Technical Committee on Inspection and Control consisted of nine members as follows: Manson Benedict, chairman; L. W. Alvarez; R. F. Bacher; L. A. Bliss; S. G. English; A. B. Kinzel; P. Morrison; F. H. Spedding, and myself.

The committee spent about 6 months of intensive full-time study on the detection of nuclear weapons manufacture on a worldwide basis and the control of nuclear weapons, the very issues which have been the basis of all our recent State Department concerns. We published a report which was about 2 inches thick that reviewed every way of detecting nuclear weapons, every way of making them, and every way that we knew at that time of controlling them. Very little additional technical information has been developed since. The IAEA, the International Atomic Energy Agency, has worked in this area. The AEC worked on it continuously with study committees of various kinds. The general answer was that if you want to make weapons on a small scale, it is very easy to do and is very hard to detect. If you are going to do it on a large scale, it is probably detectable. There were a lot of technical details in the report. The report, as far as I know, is still classified.

This was before the days of nuclear power. This was in 1946. What has happened since then? We have had two things happen. One was the atoms for peace program which opened nuclear technology worldwide, and the second is the growth in nuclear power.

We have educated the world's technical personnel on all aspects of nuclear power and nuclear technology. It is an illusion for anyone to think that any nation of the world, even the little ones, cannot assemble sufficient technical people to take the small-scale steps to handling nuclear technology. The United States undertook to do that, and I'm sure this committee has heard about this. The national laboratories had enormous programs for such international education.

At that time I was the head of Atomics International and I was literally ordered by the Atomic Energy Commission, under the threat of cancellation of all our support, to release all the information on liquid metal reactors to Euratom. We educated the Europeans on how to build liquid metal cooled reactors—the French, the Germans, and all the members of Euratom.

Now the result of this past U.S. program is that anyone who wants to find out, or wants to undertake to make weapons material, by enrichment or by reactors, can either read about it in the books or has had the training in the United States. And so we find that places like France and India and China—places which were not initially in the weapons business—are in the position to make weapons and have demonstrated it—and all of this without relation to nuclear power.

Now let me say something about the issue of the plutonium economy, the danger of which appears in all this administration's literature as a justification for the INFCE study. It was clear to those of us who knew the business that this was just an antinuclear handle to raise new fears in the public mind as to the dangers of terrorism and nuclear holocaust. It was not really a new issue, as weapons material had been made by the nuclear nations, including the United States, for almost 30 years with no evidence of theft or terrorism.

But it was built up as a huge potential threat that material would get stolen out of the power systems and out of the fuel cycles, and that we would be faced with all kinds of weapons. I consider the raising of that red herring a master public relations stroke. It was eminently successful and scared everybody. Now, one of the reasons the INFCE study failed to sustain the U.S. position, as you've heard before and as you are going to hear this afternoon from the other testimony, is that the technical basis for the U.S. posture was completely false. And every other nation that was involved and had any technical background knew it was false. It just wouldn't stand up to technical analysis. It was clear that the U.S. position was ideological in origin, and the ideology was an antinuclear one. This was just another way to stop nuclear power. INFCE was perceived by foreign countries as an attempt to pressure them to accept the U.S. ideological domestic position, and obviously they resisted it. It was clear to anyone who examined it, that the U.S. posture of setting a domestic example of restraint was a transparent nonsense.

If the basic objective was to prevent nuclear weapons from becoming a common element of every nation's military arsenal, and if the setting of an example is an effective international device, then why didn't the United States stop making weapons or destroy its stockpile as an example? As you know, the Indians have raised this question with us. It is obvious that this was a naive position—that we were going to set an example that everybody was going to follow. It is clear that other nations certainly do not accept this kind of a position.

It was clear as early as 1946 that the issue of nuclear weapons was one of international diplomatic concern, and had to be handled that way. It was quite evident all through the period until this administration that U.S. domestic nuclear policy had very little to do with that international problem. The thrust of my testimony is that there is absolutely no reason that domestic nuclear policy had to be modified, or destroyed, which it actually has been, in order to establish this kind of imagery.

There are several points I would like to make and then I would like to end my comments. One is that nuclear weapons proliferation has a very small connection with nuclear power and always has had. The reason is very simple. The size of facilities you need for limited production of weapons are really so small that almost any country of the world, if it wishes to do so, can get these facilities at a fraction of the cost that a single nuclear station would cost.

When you engage in such a small military exercise, the commercial issues that put cost limits on nuclear power do not exist. So you can afford to be redundant. You can afford to be extravagant and still come out with very low cost. You can build quick and dirty facilities. We did it in the United States at the beginning of World War II. One can overdesign all the equipment, because it is modest in size, the temperatures are low, and the performance requirements are low. The result is that anyone who wants to do this can do it technically in an easy way.

A second technical point is that the recycle of plutonium and use of fast reactors are absolutely inevitable as an energy source. No society with any kind of common sense is going to forever give up the potential of the energy economies that come from the use of plutonium and fast reactors. And if fast reactors aren't ready, and you have the plutonium stored in any fashion, even in spent fuel, you're going to use it.

The final technical point, which is one which has been obscured in all of the demagogic discussion of the breeder program, is that fast reactors are the surest way to dispose of plutonium by burning it up. The conversion ratios are adjustable. You don't have to breed any excess fuel if you don't want to, but you can use up all your uranium resources.

And when the plutonium is in the fast reactor system, it is completely inaccessible except for a very limited number of points which are very easy to protect. So, in summary, I have the opinion—and have had for some time—that our recent national posture and the INFCE study was a charade. It has been a "con job" on the American public. It hasn't fooled the rest of the world, but it has destroyed our position internationally in nuclear power.

That is the end of my comments. I would be happy to answer any questions.

[The prepared statement and additional questions and answers asked of Dr. Starr follows:]

EPRI

COMMENTS
ON THE
INTERNATIONAL NUCLEAR FUEL CYCLE EVALUATION

CHAUNCEY STARR
ELECTRIC POWER RESEARCH INSTITUTE
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TESTIMONY
BEFORE THE
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
WASHINGTON, D.C.
JUNE 5, 1980

ELECTRIC POWER RESEARCH INSTITUTE

Mr. Chairman and Members of the Committee:

My statement on the relationship of the INFCE (International Nuclear Fuel Cycle Evaluation) study to U.S. energy policy will be brief and, I hope, helpful to the Committee. As some members of this Committee know, I have followed and publicly commented upon U.S. nuclear policy for many decades, and most recently, I have given close attention to the content and implications of the INFCE study.

As most of you know, I have been a proponent of an aggressive nuclear power program for the United States. I believe this country must develop and use every electricity alternative, which is reasonably feasible, to maintain its domestic welfare, and I consider nuclear power as one of the essential parts of such a national energy mix. I am also deeply concerned with our national security, and, in particular, with the issue of nuclear weapons proliferation throughout the world. There is certainly no doubt in my mind that reducing the risk of nuclear war must be the highest priority objective of our foreign policy.

With these two national objectives -- domestic welfare and international peace -- in mind, it is my strong belief that this Administration's policies with regard to nuclear power, both nationally and internationally, have been clearly counterproductive to the achievement of these objectives. In fact, the recent policies that the Government has enforced could not have been better designed if their objective was to weaken the United States both domestically and internationally

I make these statements in full recognition of the good intentions expressed by the Administration with regard to the issues of both nuclear power and

and nuclear weapons. Unfortunately, it was clear to many of us that the Administration's initial positions were based on technical ignorance and political romanticism, with little insight to the realities of nuclear power and nuclear weapons systems. These realities were called to the Administration's attention at the very start of its consideration of these matters in a report from the Select Committee for the LMFBR Program Review, delivered to the President at his request on April 6, 1977[1]. This study explored alternate breeding cycles and their proliferation risks, and drew very similar conclusions to those in the INFCE report just issued. I have taken the liberty of including findings and conclusions (p. 1 - 17) from this earlier report as an attachment to this testimony.

Unfortunately, the Administration elected to seek non-existent technical fixes for proliferation as a matter of foreign policy. The resulting confusion in our nuclear policies has produced results which are truly counter to our own interests and to rational approaches for strengthening international agreements for diminishing the risk of proliferation. We are regarded now as an unreliable partner in nuclear fuel agreements. Thus, other nations are expanding their programs for enriched uranium supply, or initiating enrichment programs of their own, or seeking agreements on fuel supply from other supplier nations outside the Western Bloc.

By renouncing the plutonium breeder and stopping our own work on fuel cycle -- reprocessing, fuel fabrication, waste fixation and disposal -- we have lost our position of influence in the broad technical community of nations where this work continues. We no longer have privileged, detailed knowledge of what other nations are doing. Before April 1977 and before the freeze on reprocessing and breeder development, we were influential partners with many nations because we had useful, practical knowledge to bring to the policy making. Now we are rarely asked; we have nothing much new to add to the pool of knowledge. We are considered to be so uncertain as to national intent as to be excluded from real policy discussions. As a result, we shall soon be in the position of importing nuclear equipment which has been demonstrated abroad, based on technology originated years ago in United States laboratories and production plants.

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[1] Report by the following members of the LMFBR Steering Committee, unpublished by U.S. ERDA (April 6, 1977): T. G. Ayers, M. Benedict, F. L. Culler, J. L. Everett, III, R. V. Laney, C. Starr, and C. F. Walske.

The counterproductive potential of the Administration's early proposals was also publicly assessed, and its counterproductive outcomes were predicted. Many professional and detailed analyses of this issue were publicly presented during 1977, and their general thrust is typically represented by the following quotation from my paper given at the American Power Conference, April 19, 1977:

> "It is certain that neither the U.S. nor the world has the choice of severely limiting nuclear power, and that the reprocessing technology and breeder issues have only a thin and controllable link to proliferation. These facts, unpalatable to some though they may be, must be constructively addressed -- politically and institutionally.
>
> It is a disservice to the people of the U.S. -- and the people of the world -- to create the illusion that by putting restrictions on civilian nuclear power, we have somehow solved the proliferation problem. Unintentional

> though it may be, such steps would undoubtedly be counterproductive to their stated objectives by creating resource conflicts, removing faith in the U.S. umbrella to protect the welfare of its allies, and stimulating the expansion of indigenous nuclear capabilities abroad, including enrichment and reprocessing.
>
> Finally, one may well ask, who would benefit from such a policy? The oil-exporting nations, of course, and those nations which are continuing to develop all their nuclear power options without restriction."

Nevertheless, the Administration chose to disregard all these comments and to insist upon its views, for reasons which might merit discussion on some other occasion.

The Administration's official position was presented as arising from the assumption that the growth of nuclear power in any nation might eventually lead to the chemical separation of plutonium from spent fuel, for the purpose of recycling this plutonium into the nuclear power system as a fuel, either in our present reactors or in a future fast reactor cycle. It was the Administration's position that such a chemical separation process would permit easy diversion of the plutonium from the fuel cycle to weapons.

On this premise, the Administration undertook the following steps:

1. to halt within the United States all programs which would permit chemical reprocessing of spent fuel, or would encourage the development of the fast reactor cycle;

2. to persuade the other industrial countries already engaged in nuclear power activities to do the same;

3. to persuade the developing countries not yet engaged in nuclear power that chemical reprocessing should not be a part of their future planning; and

4. to reopen consideration of alternate reactors and fuel cycles as a substitute for the Pu breeder, with emphasis on proliferation resistance.

To back up this posture, the Administration's agencies undertook to prove internationally that recycling of plutonium in our present light water reactors would be uneconomic for a long time to come, and, further, that there was enough uranium available worldwide so that the need for the more fuel-efficient fast reactor cycle would not develop for many decades. Certainly, if this were indeed the case, then, presumably, reprocessing and the breeder could be deferred for some future generation to consider. Because such projections concern the future availability of uranium ore, its cost, and its availability worldwide -- all involving estimates of great uncertainty -- the subject was inevitably one which aroused professional dispute. In addition, the costs of recycling and the economics of the breeder, while uncertain, were potentially in the competitive range of fossil fuels. By carefully choosing the extremes of these uncertainties, the Administration constructed a rationale to superficially justify its deferment policies. Clearly, the foreseeable risks associated with such a program (i. e., of deferring for a long time the options of chemical reprocessing and the breeder) were not acceptable to other nations, as evidenced by the INFCE report.

In view of the continuing U.S. nuclear weapons production program, the Administration's publicly stated reason for indefinitely deferring the domestic development and demonstration of chemical reprocessing and fast reactors was clearly not intended to prevent diversion within the U.S. Rather, the U.S. wished to show the rest of the world that nuclear power could go ahead without these two steps being contemplated as part of a near-term program. It was a certainty to many of us early on that the other industrial nations would not find U.S. policy consistent with their own internal analysis of the situation; and it should be clear now to everyone from the INFCE report that the other industrial nuclear countries have not accepted the U.S. premises as wise for themselves. Further, there now appears to be no excuse whatsoever for deferring a rational domestic program for the purpose of setting an example for the rest of the world. It is evident to many of us that the U.S. policy is now an absurd position, if the ostensible purpose was, and is, to set an international example. We are denying ourselves while others proceed; and, in the process, we have lost the confidence of much of the rest of the world.

What has been the pragmatic effect of the Administration's U.S. nuclear policy and of the INFCE study? Domestically, the U.S. nuclear power development has been very seriously impaired, if not fatally injured as yet. The lack of activity on chemical reprocessing and on the fast reactor has raised serious doubts as to the Administration's basic interest in developing nuclear power as a major source of electricity for the future. It has also resulted in the very practical question of how to handle, for an indeterminate period of time, the spent fuel from the present light water reactors. Should this valuable resource be permanently buried in some irretrievable manner? Should this fuel be retrievably stored for an indefinite period, so as to provide us with plutonium fuel at some future date? Should we develop the option of chemical reprocessing and of fast reactors to use up the plutonium? We are left with the inescapable requirement that certainly this spent fuel will have to be stored somehow, if we do not plan for its long-term disposition.

Internationally, most industrial nations that are already embarked on nuclear power systems of substantial magnitude do plan to reprocess and to use the plutonium as fuel for fast reactors. If the development of the fast reactor takes longer than expected, most of these nations are keeping the option open to recycle the plutonium in their conventional present reactors.

Unfortunately, a most dangerous political consequence of U.S. policy is the creation of a serious dilemma for the developing countries who are now initiating their entry into nuclear power as an energy resource. They are faced with the situation of either storing spent fuel, with its valuable energy content, shipping this fuel to some industrial country that would be prepared to reprocess it, or establishing their own reprocessing activities. Further, the U.S., by promoting international concern over the diversion of material from the power cycle, has sensitized these countries to the possible interference of foreign nations with their use of plutonium as a supply, potentially a major energy resource for them. As this Committee has heard before, the U.S. now has a reputation internationally of being a capricious nuclear supplier, as well as a wavering partner in nuclear programs of any kind. The pressure that this Administration has placed upon the industrial allies of the U.S. to follow U.S. direction in these matters and to bend the intent of the Non-Proliferation Treaty most of them signed has certainly given concern to the developing countries as to the integrity of international understandings in this area. It is my very strong impression that most of these countries are quietly preparing their internal technical skills to undertake their own reprocessing at such time as this appears to be politically the prudent thing to do.

On the positive side, the INFCE study has succeeded in bringing to the attention of most of the governments of the world the need for an international policy concerning the handling of nuclear fuels. I hope that this consciousness will result in positive steps to establish such controls and to give us the kind of international supervision of these activities which was one of the purposes of the International Atomic Energy Agency. The INFCE study also stimulated several proposals to reduce the risk of diversion of plutonium by technical and industrial means. It is now generally recognized that spent fuel stored for a long period of time can be chemically processed for the separation of plutonium in a dedicated military facility with relative ease and low cost. Thus, the absence of an industrial chemical reprocessing facility does not guarantee that plutonium cannot be made available for military weapons. On the other hand, commercial processes for making plutonium-bearing fuels can be modified so that the diversion of plutonium from a nuclear power cycle can be made very difficult. In my opinion, accessible long-stored spent fuel is no less a potential military risk than is a diversion-resistant chemical reprocessing facility. If we accept one, we should accept the other.

It has frequently been suggested that an international system for handling spent fuel could be so managed that spent fuel would be shipped to a few major reprocessing centers, internationally monitored, located in the large nuclear powers, where plutonium would be separated and be used primarily in fast reactors. Those nations that made their spent fuel available to these international centers would, in turn, be given fresh uranium fuel from the various uranium enrichment centers which are presently available in the major industrial countries. In principle, this would concentrate the bulk of spent fuel and plutonium in a limited number of international centers which could be more easily monitored and controlled.

It is very important to emphasize that the manufacture of nuclear weapons material, either enriched uranium-235 or plutonium, is a relatively straightforward matter for even a modestly competent nation, and relatively inexpensive compared to the cost of nuclear power plants and their ancillary supporting industrial and technical structure. The cost of such militarily dedicated facilities is relatively modest because of small size, low technical efficiency, and absence of commercial criteria on safety -- they can be "quick and dirty." We should recognize that all the nuclear weapons that have been made to date have come from facilities other than nuclear power cycles, and, in a few suspected instances, from very modest facilities indeed.

While it is true that the technical skills which result from the development of a complete commercial nuclear power system, including reprocessing and fuel manufacture, can be applied to the development of a military production system, it is also evident to many of us that the availability of a nuclear power system makes a relatively minor increase in the potential for nuclear weapons proliferation. The international reduction of the nuclear weapons threat is a political issue of very great importance. It can be dealt with best on a political level. It cannot be prevented by the denial of nuclear power to the nations of the world.

I would like to end my comments with the positive suggestion that the United States attempt to reestablish itself as a constructive leader in the development of nuclear power, and as a constructive leader in the development of international systems for doing so safely and with minimum proliferation risk. We should build upon the Non-Proliferation Treaty and the established safeguards of the International Atomic Energy Agency. We certainly cannot reestablish leadership if we domestically deny to ourselves the benefits of nuclear power and the benefits of developing the chemical reprocessing option and the benefits of developing the fast breeder option. In our original atoms-for-peace program, the United States promised the rest of the world that it would help develop civilian nuclear power for peaceful purposes, so as to provide a new major energy resource for the world's needs. I am more firmly convinced than ever that this was a worthwhile goal, and that the U.S. leadership toward this objective should be reestablished. It is time now to take the international steps to develop an expanded set of agreements and processes to minimize the weapons proliferation risks, and to recognize that nuclear power is rapidly expanding worldwide.

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ATTACHMENT*

*This information taken from the April 6, 1977 report of the LMFBR Steering Committee, prepared at the request of the Chairman of ERDA and the President of the United States.

LMFBR PROGRAM REVIEW

by the following members
of the
LMFBR REVIEW STEERING COMMITTEE

T. G. Ayers	*Chairman*, Commonwealth Edison Company
M. T. Benedict	*Professor of Nuclear Engineering*, Massachusetts Institute of Technology
F. L. Culler, Jr.	*Deputy Director*, Oak Ridge National Laboratory
J. L. Everett, III	*President*, Philadelphia Electric Company
R. V. Laney	*Deputy Director*, Argonne National Laboratory
C. Starr	*President*, Electric Power Research Institute
C. Walske	*President*, Atomic Industrial Forum

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*Attachment to Testimony Presented by Chauncey Starr, Vice Chairman, EPRI.

1. FINDINGS AND CONCLUSIONS

After careful consideration of the energy options that will be available to the United States for the next 50 years, fully aware of the encouraging progress and potential for energy conservation, and fresh from the uncertainty of the debates about how much energy will be needed in the future, we have concluded, like many groups before us, that nuclear energy will be used in most parts of the world to replace in part the rapidly diminishing supplies of oil and gas. That nuclear energy is a mixed blessing was demonstrated by our first wartime application of its power, the image of which still haunts our best efforts to satisfy a growing population with energy.

Because, to the best of our knowledge, uranium is in limited supply, it now seems to many members of the Steering Committee, particularly those who have the responsibility for supplying electricity to various parts of the United States, that breeders will most probably be needed within the next few decades and that they offer the only proven technology for a long-term energy source.

This conclusion is not shared by those on the Committee who think that we will need less energy than we predict and who see too great a risk in nuclear energy and the breeder to form a commitment to its development.

Of course, they could be as right about the future as we, but if they are wrong the risk of insufficient energy supply to our highly developed society is great. On so vital an issue as our future energy supply, we must recognize not only uncertainties and concern but the consequences of errors in judgment which may preclude the use of an option in the future.

With certainty that we cannot now afford to preclude the breeder option, we make the following recommendations and submit the following findings.

1.1 Breeder Option

1. The breeder option should be pursued and kept open for possible use in the medium and long term. It is unlikely that breeders will make a significant contribution to power generation in the United States in this century, since development and demonstration of this option will require another 15 or 20 years under the most favorable conditions and with a continuing and vigorous program. There is a considerable time lag between decision dates and the time when a reactor produces power. To have the first breeders in operation by about the year 2000 requires that a decision to build be made about 10 to 15 years earlier.

2. After reviewing the need for and timing for breeders, we conclude that they may be needed as early as 1990 or 1995, or as late as 2000 or so. The actual decisions for deploying breeders need not be made now but can be made later, when better assessments are available of demands for energy and electricity, the supply of and the capability to produce natural uranium, the practical limits on the production and transportation of coal, the effectiveness of conservation measures, and the contributions of auxiliary sources of energy. Because of the considerable time lag already referred to, it is recommended that a commitment to the breeder become a part of the new energy policy.

We note again, for emphasis, that the actions required for the full and timely development of the breeder option can and should be separate from the decisions to commercially deploy; this separation should be a prime element of the program structure.

1.2 Proliferation

3. The need to minimize the potential for proliferation of nuclear weapons and the diversion of fissile materials which could result from the use of all types of reactors, not just breeders, is recognized as

To be effective, controls and agreements must be acceptable to both supplier nations and users and must be compatible with the self-interests of each. The United States cannot unilaterally create such agreements nor by itself determine the type and pace of development of breeders and their necessary fuel cycles.

We studied with care the new policy on proliferation and diversion, and Dr. Robert Fri helped us by explaining some of the reasoning behind it and its implications on the use of plutonium in breeders in the United States. We responded to the request to explore technical alternatives that might reduce the potential for proliferation. Common to all technical alternatives for any reactor cycle is the use of energy centers and/or secure reprocessing and fuel fabrication centers, perhaps developed and operated under international safeguards and monitoring. International control of such centers is a political solution. There is no technical fix which can operate without political agreements among nations.

4. Because the plutonium-uranium fuel cycle is surely the most efficient breeder cycle (i.e., it produces the most excess fissile material per unit production of heat) and because it is the fuel cycle of light-water reactors, we suggest that the government proceed with the demonstration of this fuel cycle on a limited basis, perhaps through the operation of one colocated fuel reprocessing and refabrication center. This center can be used to develop understanding and techniques for safeguarding, coprocessing, fission product spiking, physical security, and advanced techniques for real-time accountability.

This experimental center need not signal the initiation of plutonium recycle to reactors, but it will provide a basis for proceeding with such centers in the future, if the option is chosen in the future. It might also provide a site for testing advanced techniques for fissile material control which can be exchanged with other nations who now have reprocessing and recycling facilities, or who may in the future build them.

Studies of the possibility of reducing the potential risk of weapons proliferation by technical means, such as the use of denatured cycles suggested by Taylor et al., are relatively new in the nuclear community. During this review we explored many such cycles. We find that denatured cycles of a great variety can be made to work but that only a few have a high resource efficiency; we found only one that produces a net gain of fissile material. This net-gain cycle, described later, requires the use of breeders, probably fast breeders. The denatured breeder cycles and those which use advanced converters have not been adequately explored to determine their technical feasibility, economics, and relative effectiveness in minimizing proliferation risk. Given the present technical uncertainties about what type of breeder and fuel cycle provides the best insurance against proliferation, we recommend that these alternative breeder cycles be subjected to study, development, and demonstration as possible alternatives, but as adjuncts to, not replacements for, the more efficient plutonium-uranium breeder.

Programs to explore these potentials should be initiated and the promising ones carried to the demonstration stage, but without delaying the development of the plutonium fast breeder option.

5. The alternative breeder cycles were studied using the following assumptions:

a. Light-water reactors will be used to generate most of the nuclear power in the United States for the remainder of this century. Spent fuel, with its plutonium, will be stored without processing or, alternatively, reprocessed in secure fuel-cycle centers without recycling plutonium.

b. All fuel outside of energy centers or fuel reprocessing centers will be denatured, using uranium 233 diluted with uranium 238.

c. Plutonium and other purified fissile materials will not be used in converters or breeders, except those in controlled secure energy centers or parks.

d. Denatured spent fuel containing plutonium will be returned without reprocessing to a safeguarded fuel center.

e. It should be pointed out that all cycles using denatured uranium 233 require reprocessing.

The reactors and fuel cycles reviewed as alternatives to the plutonium-uranium fast breeder *all required a breeder* in which plutonium was converted to uranium 233 using plutonium as a fuel and thorium as the fertile material. This breeder using plutonium fuel was located in a safeguarded secure center; the bred uranium 233, denatured with uranium 238, was assumed to fuel either high-gain converters or fast breeders fueled with denatured uranium 233, all located outside of a secured energy park.

Of all the fuel cycles and reactor combinations examined, only those which combine an in-park plutonium-fueled uranium 233 fast breeder with fast breeders fueled with denatured fuel (outside of the secure energy center and available for deployment without restrictions) produced a net gain of fissile material. All combinations of breeders and advanced converters were net consumers of fissile material. All breeders and advanced converters require reprocessing and fuel recycle. All denatured cycles involve significant quantities of plutonium, which must be returned from the dispersed reactors unprocessed. *Thus, even denatured uranium 233 fuel cycles require breeders to produce a net fissile gain*. Fast breeders will operate more efficiently than others.

6. We also observe that proliferation—the election of a sovereign state to produce nuclear weapons—and the diversion of fissile material for terrorist purposes are separate problems. Within the United States only diversion should be of concern; our domestic breeder program can proceed without increasing the risk of proliferation, particularly since other nations are well advanced in breeder development.

7. Fissile material of superior quality for weapons can be produced by several methods not dependent upon breeder and nuclear power reactors. There are at least six such approaches that are not now subject to safeguards. Even with breeders or other plutonium-producing power reactors, a nation which elects to produce weapons might well use one or more of these alternatives because they may be more efficient, are less costly, involve less difficulty internationally, and are capable of producing fissionable material in a comparable period of time to diverting plutonium from power reactors.

8. Further, some members of the Committee hold the view that *diversion* of fissile material *within the United States* can be controlled, based on experience with safeguarding large quantities of fissile material since 1944. Guarded and controlled fuel cycle facilities, guarded and device-protected shipments, careful real-time accountability, and the use of internationally supervised resident inspectors will control this diversion risk to acceptable levels. This risk can be reduced somewhat by technical means, such as coprocessing, isotopic dilution where applicable, and making fresh fuel sufficiently radioactive to deter would-be diverters.

9. Proliferation of nuclear weapons (the election of nonnuclear weapon states to produce nuclear weapons) is not subject to solution by technology alone. In fact, there is no known technical fix, and there is little possibility that one can be found. Proliferation must be controlled primarily by political means. Given politically accepted and binding agreements, technology can assist in assuring reasonable compliance with the political solutions.

1.3 Timing of the Breeder Option

10. The urgency for the breeder is the second major question which we reassessed. Our conclusion is that there is urgency to develop the breeder option; development should neither be interrupted nor delayed until the next century. The supporting argument for this recommendation, endorsed again

during this study, can be stated as follows: The diminishing domestic supplies of oil and gas, together with probable restrictions on the rate at which coal can be mined, shipped, and burned, place constraints on the use of these fuels for the generation of electricity. In this century, nuclear power supplied by light-water reactors prior to breeders will place heavy demands on our estimated domestic reserves and resources of natural uranium. If 1200 GW of electrical generating capacity (total) is required (a mid-range estimate in this study) by A.D. 2000, 400 to 500 GW may be nuclear. This nuclear capacity will require (over the operating lifetime of 30 years) 2 million to 3 million tons of natural uranium. This requirement may come close to exhausting our uranium supply, thus limiting our ability to continue the nuclear option if the breeder is not available for use in time. The breeder option should be available for deployment, if needed, by the 1990s.

The present pace of breeder development and demonstration, of which the CRBRP is a timely and essential component, will meet the option date.

11. This position is based on the following estimates of domestic uranium reserves and resources, expressed as short tons of U_3O_8:

	Millions of tons
Probable maximum	3.7
Prudent planning base	1.8 2.0

This estimate recognizes that our *known reserves* total about 680,000 tons and that the reasonable *probable resources* might add 1.1 million tons to this figure. Their sum is our suggested prudent planning base. The estimate of 3.7 million tons includes possible and speculative resources yet to be located. These estimates are generally endorsed by uranium geologists, although there is debate about the level upon which prudent planning should be based.

There is also concern about the rate at which undiscovered resources can be found and brought to production.

Other groups reviewing this very pivotal question of future uranium supply (specifically the recent Ford Foundation report) suggest that much more uranium can be found at economically and environmentally acceptable costs. They formed these judgments using the same basic data on uranium availability, but they seem more willing to gamble on future discoveries than we think prudent. They present no substantive geologic arguments to support their higher estimates.

1.4 Advanced Converters

12. The demand for natural uranium could be reduced by the use of more efficient reactors of the high-temperature gas-cooled or heavy-water-moderated thorium cycle types. To conserve natural uranium, these reactors must operate on the thorium cycle.

However, the contribution that these advanced converters can make to a reduction of uranium consumption depends not only on their energy resource efficiency but, more important, upon the time at which they can be installed in large numbers by utilities in the United States. We do not believe that any advanced converter will be demonstrated sufficiently for widespread use before 1990 or 1995. They may not economically compete with light-water reactors, and they require reprocessing and full fuel recycle.

We therefore conclude that the deployment of advanced converters will come too late to significantly affect uranium consumption under the nuclear growth considered. Except at the lowest projection of installed capacity, 200 GW—the nuclear moratorium case—very little additional time is gained before all uranium is committed and reactor orders cease, 5 to perhaps 15 years at most. For the more probable estimate of 400 GW of nuclear power by the year 2000, followed by overall growth of about 3.3% per year, the 3.7-million-ton upper bound would be reached only five to ten years later than with light-water reactors alone. In our view, such a small gain raises questions as to the advisability of approaches based on the deployment of advanced converters in the United States.

13. Because of the uncertainties as to the uranium resource base, we recommend that a major effort be undertaken to improve our knowledge of the uranium available in the United States, including Alaska. Further, support should be given to the worldwide search for uranium.

1.5 Clinch River Breeder Reactor

14. We come now to the consideration of the Clinch River Breeder Reactor Plant. After reviewing again its aims and objectives, its value in the demonstration of integrated breeder technology, and its value as a focus for the overall breeder program, we conclude that such a demonstration project is essential and that the present schedule for the CRBRP is timely and appropriate. We can find no basis for challenging the fundamental validity of its original objectives; our review resulted in a strong reaffirmation of these objectives.

15. We conclude that a demonstration plant of the approximate size of CRBRP is necessary and that the CRBRP objectives are appropriate to that demonstration plant. The design basis is current. We point out to certain critics of the CRBRP that the LMFBR program is not constrained forever to use the specific features and functional characteristics included in the CRBRP. Different reactors of the fast type will be built, but all will benefit from the CRBRP proof of breeding and operation. Many improvements will result from tests performed and alternative designs tried out during the 30-year lifetime of the CRBRP. In an evolving technology, it is not possible for any one demonstration to be totally prototypic of the future. Much has already been learned from the design. Even though changes for optimization are possible and have been suggested, the information and experience gained is urgently needed. The next design for a breeder prototype, if one were to be developed, would be out of date by the time it was translated into concrete and neutrons.

We were asked to consider a three-year delay for the CRBRP. We report our analysis of what a delay will do to the LMFBR program in the later sections of this report. In summary, the delay will create unnecessary disruption to the infrastructure of the LMFBR program, which is now centered around this experimental reactor; costs will increase significantly due to delay alone. We recommend against a delay of three years.

An analysis of termination of the CRBRP has also been provided. We recommend that the CRBRP be built along with the supporting fuel recycle hot pilot plants and other facilities.

16. We conclude that the CRBRP is a necessary and essential step in development of the LMFBR energy option.

17. As indicated in the foregoing, the first and most important objective of the CRBRP is to demonstrate that a sodium-cooled fast reactor can be licensed and operated reliably. This should be done by completion of CRBRP systems, components, and structures as they are now defined, on the present schedule. But we suggest that throughout its lifetime the CRBRP will be an appropriate and versatile test bed for alternative and improved components (such as sodium pumps and steam generators) and for advanced plutonium-uranium fuels.

18. We firmly believe that the first core of CRBRP should be plutonium oxide with a uranium 238 blanket, since this is the combination which provides the highest breeding gain. Alternatively, the first loading could consist of uranium 235 as the fissile component and uranium 238 as the fertile, if plutonium is considered undesirable as fuel for the first cores.

As a result of the preliminary study of alternative cycles for possible reduction of proliferation potential and some detailed design studies, we suggest an additional justification for the CRBRP.

19. After demonstrating the operating characteristics of the CRBRP on the plutonium–uranium 238 fuel cycle, the CRBRP could be operated as a breeder test bed for the alternative fuel cycles using denatured uranium 233 and thorium. Evaluations have been made of the uranium 235–uranium 238 core with thorium blankets for CRBRP. We conclude from these studies that CRBRP is sufficiently flexible to demonstrate alternative fuel cycles using the uranium 233–thorium cycle.

1.6 Consideration of the Use of Foreign Technology

20. We think that there is ample justification to pursue more vigorously all avenues for acquiring information, data, and experience on the fast reactor programs in France, Germany, England, and Russia. Testing of components manufactured in the United States for use in foreign test facilities should be considered. We have much to gain and little to lose.

We recommend joint programs on major projects to reduce development cost and improve the depth of understanding. This approach would be particularly appropriate for the development of the back end of the breeder fuel cycle.

Possibly the most valuable foreign input to our program would be the operating experience from any one of the foreign plants.

We suggest that the possibility of foreign exchange will decrease significantly if CRBRP is not built and operated. In its absence, we will have little to offer. The foreign programs are now proceeding to commercial-scale prototypes, while we are testing only at FFTF size, a mismatch so large that the information obtained or given cannot be useful.

We should not become dependent on the importation of licensed foreign reactors, but if the United States program is delayed too long, say if the CRBRP is not built and the technological infrastructure is dissipated, it may be very necessary to buy foreign reactors and to encourage the importation of foreign technology into the United States. Cooperative programs in fuel reprocessing and refabrication should be explored soon, since other breeder-developing nations are just now initiating pilot-plant programs in this area.

1.7 In Summary

We have concluded that the United States urgently needs to have a breeder option available for possible deployment before the year 2000 because of uncertainties in the availability of fossil fuels and uranium supplies.

There are technological choices which, in suitable political contexts, may somewhat reduce proliferation risks; of these, only those that employ breeders preserve the breeder option in the long term. These alternatives must be coupled with political agreements to have any significant effect on proliferation potential internationally. These same political agreements should suffice to control the plutonium-uranium breeder cycle; there is only a difference in degree between the plutonium and the uranium 233 denatured cycles. Further, our evaluation of alternative cycles has indicated that fast breeders are essential to any proliferation-resistant system capable of providing a net gain in fissile material.

For these reasons, we strongly recommend that the plutonium-uranium breeder program proceed as planned. This includes a reaffirmation of the timeliness and appropriateness of promptly constructing the CRBRP and its associated fuel cycle facilities in order to validate the LMFBR option. Alternative cycle studies should be pursued but without significantly delaying the current program. The CRBRP and its fuel cycle facilities can be used to test alternative, denatured uranium 233–thorium cycles.

2. ENERGY AVAILABILITY AND PROLIFERATION PROTECTION POTENTIAL OF ALTERNATIVE NUCLEAR ENERGY SYSTEMS

Key indicators which relate to the difficulty of controlling weapons proliferation, on an international level, and to the ultimate energy which is recoverable have been compiled for several different nuclear energy systems. These systems include throwaway fuel cycles, thorium fuel cycles, and plutonium recycle systems. Shown for each system is the amount of special nuclear material available, the form of the material, and an indication of the time which would be involved before a nation could obtain the special nuclear material. Note that special nuclear material availability refers only to that material available outside of any internationally secured areas which might be a part of any particular system. Also shown for each energy system is an indication of the total nuclear capacity which could be achieved by each system, the length of time that the system could be maintained, the long-term growth potential of the system, and the split between dispersed reactors and energy-center reactors. These features are summarized in Table 2.1, while line drawings of each energy system type are given in Figs. 2.1 through 2.7.

The conclusions which can be drawn from the data in Table 2.1 are given below.

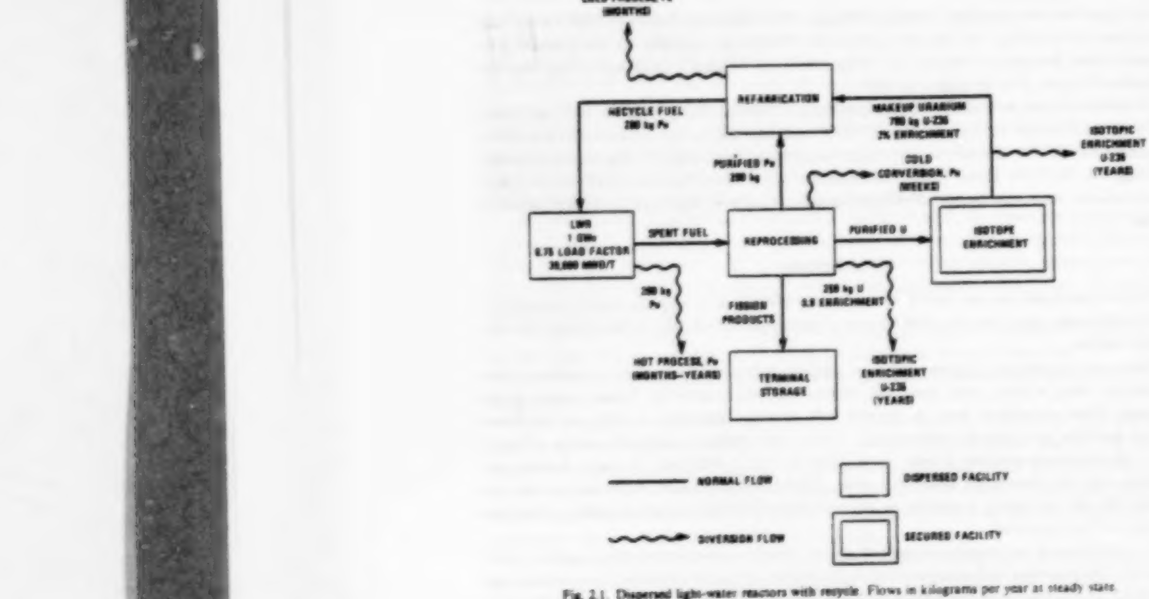
COLD PROCESS, Pu (MONTHS)
REFABRICATION
RECYCLE FUEL 280 kg Pu
MAKEUP URANIUM 780 kg U-235 2% ENRICHMENT
ISOTOPIC ENRICHMENT U-235 (YEARS)
PURIFIED Pu 280 kg
COLD CONVERSION, Pu (WEEKS)
LWR 1 GWe 0.75 LOAD FACTOR 30,000 MWD/T
SPENT FUEL
REPROCESSING
PURIFIED U
ISOTOPE ENRICHMENT
280 kg Pu
FISSION PRODUCTS
250 kg U 0.8 ENRICHMENT
HOT PROCESS, Pu (MONTHS–YEARS)
TERMINAL STORAGE
ISOTOPIC ENRICHMENT U-235 (YEARS)
NORMAL FLOW
DISPERSED FACILITY
DIVERSION FLOW
SECURED FACILITY

Fig. 2.1. Dispersed light-water reactors with recycle. Flows in kilograms per year at steady state.

Table 3.1 Comparison of nuclear system alternatives

Nuclear system	SNM availability (kg material per GWe-year of total system)				Energy availability				
	Cold conv Pu^{a} (wks.)	Hot process Pu^{a} (mos.–yrs.)	Isotope enrich U-235 (yrs.)	Hot isotope enrich.-233 (multi–yrs.)	Maximum cap. available (GWe) 1.8×10^6 tons ore	Maximum cap. available (GWe) 3.7×10^6 tons ore	Time max. cap. can be maintained (years)	Percent of energy available at dispersed sites	Long-term growth rate that can be sustained (%)
1. Dispersed LWR w/recycle; no secure area	200		700 (2%)		500	1000	30	100	0
2. Dispersed LWR – throwaway cycle w/secured fuel storage		200	950 (3%)		330	670	30	100	0
3. Tandem dispersed LWR/HWR throwaway cycle w/secured spent fuel storage		160	600 (3%)		450	900	30	100	0
4. Dispersed denatured converter w/secured reprocessing		40		850 (12%)	< 400–450^{b}	700–1600^{b}	30	100	0
5. Secured denatured breeders and reprocessing/Pu storage w/dispersed denatured converters		20		220(12%)	< 400–450^{b}	600–1300^{b}	30	40	0
6. Secured Pu cycle breeders and reprocessing w/dispersed denatured reactors									
a. Pu/U breeder w/thorium blanked and dispersed denatured advanced converter		30		550	2000	4000^{c}	50 to essentially forever^{d}	66	0
b. Pu/Th breeder w/dispersed denatured converted		35		650	600	1200^{c}	50	83	0
c. Pu/Th breeder w/dispersed denatured breeder		210		370	Essentially unlimited^{c}		Essentially forever	30–60	2–3
7. Dispersed Pu cycle breeder w/secured processing/spiking		1375			Essentially unlimited		Essentially forever	100	3–10

[a] Fissile Pu. Throughout this chapter this convention is followed.

[b] Dependent upon growth rate of overall nuclear industry, assuming availability of advanced denatured converter in 1995.

[c] The time required to start the dispersed denatured breeders can be quite long as the total system will be fissile material limited. For the case of the dispersed denatured converter, it will typically take 50 or more years to reach equilibrium. With a denatured breeder the equilibrium can be reached slightly sooner.

[d] Dependent upon fissile requirements of advanced converter. Very high conversion ratios or utility breeder systems (e.g., LWBR) could be used to run, without growth, essentially forever. However, these are not apt to be very economic machines. On the basis of present optimistic HWR designs, 50-year lifetime is more realistic.

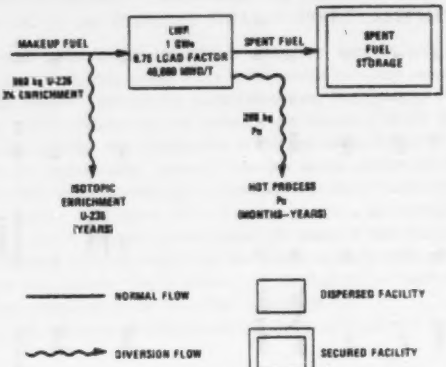
MAKEUP FUEL
LWR
1 GWe
0.75 LOAD FACTOR
40,000 MWD/T
SPENT FUEL
SPENT
FUEL
STORAGE
kg U-235
3% ENRICHMENT
kg
Pu
ISOTOPIC
ENRICHMENT
U-235
(YEARS)
HOT PROCESS
Pu
(MONTHS–YEARS)
NORMAL FLOW
DISPERSED FACILITY
DIVERSION FLOW
SECURED FACILITY

Fig. 2.2. Dispersed throwaway cycle—light-water reactors. Flows in kilograms per year at steady state.

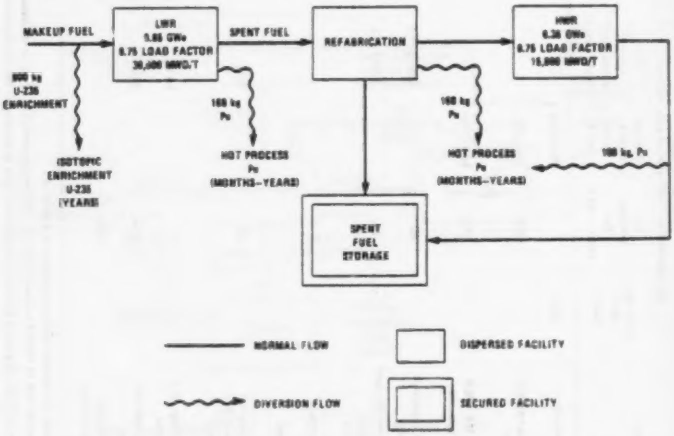
MAKEUP FUEL
LWR
0.75 LOAD FACTOR
30,000 MWD/T
SPENT FUEL
REFABRICATION
HWR
0.75 LOAD FACTOR
15,000 MWD/T
800 kg
U-235
3% ENRICHMENT
160 kg
Pu
160 kg
Pu
100 kg. Pu
ISOTOPIC
ENRICHMENT
U-235
(YEARS)
HOT PROCESS
Pu
(MONTHS–YEARS)
HOT PROCESS
Pu
(MONTHS–YEARS)
SPENT
FUEL
STORAGE
NORMAL FLOW
DISPERSED FACILITY
DIVERSION FLOW
SECURED FACILITY

Fig. 2.3. Tandem dispersed light-water reactor and heavy water reactor throwaway cycle. Flows in kilograms per year at steady state.

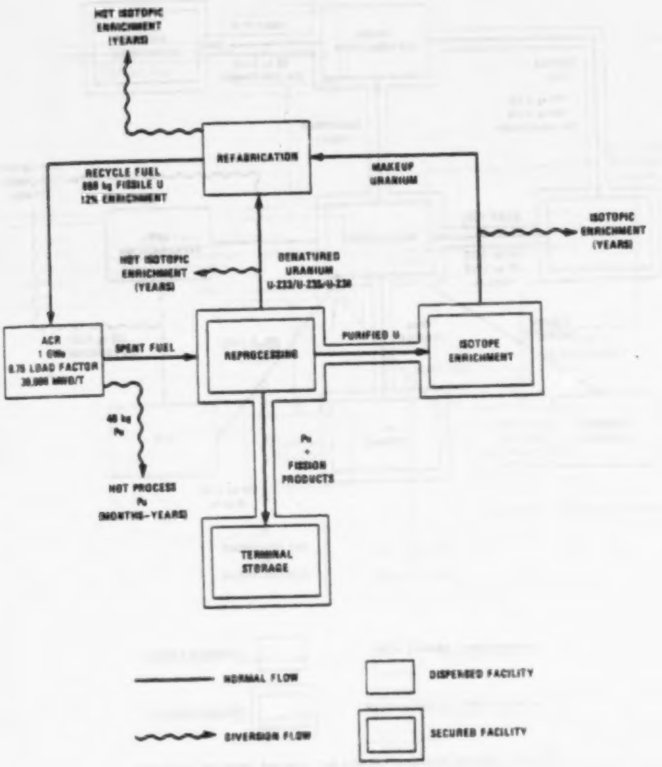
HOT ISOTOPIC
ENRICHMENT
(YEARS)
REFABRICATION
RECYCLE FUEL
888 kg FISSILE U
12% ENRICHMENT
MAKEUP
URANIUM
ISOTOPIC
ENRICHMENT
(YEARS)
HOT ISOTOPIC
ENRICHMENT
(YEARS)
DENATURED
URANIUM
U-233/U-235/U-238
ACR
1 GWe
0.75 LOAD FACTOR
30,000 MWD/T
SPENT FUEL
REPROCESSING
PURIFIED U
ISOTOPE
ENRICHMENT
40 kg
Pu
Pu
+
FISSION
PRODUCTS
HOT PROCESS
Pu
(MONTHS–YEARS)
TERMINAL
STORAGE
NORMAL FLOW
DIVERSION FLOW
DISPERSED FACILITY
SECURED FACILITY

Fig. 2.4. Dispersed denatured converter with secured reprocessing.

2.1 Proliferation Protection Potential

1. All reactor systems require fissile material, which might be diverted to produce weapons. Further, all reactor systems will produce plutonium unless the system runs on highly concentrated undenatured fissile uranium, which is itself weapons material. Thus, any system with recycle will involve handling plutonium, including thorium cycles.
2. The availability of plutonium or other special nuclear material such as uranium 233 can be changed by choice of system. The most readily available weapons material is involved with plutonium recycle systems with unsecured reprocessing.

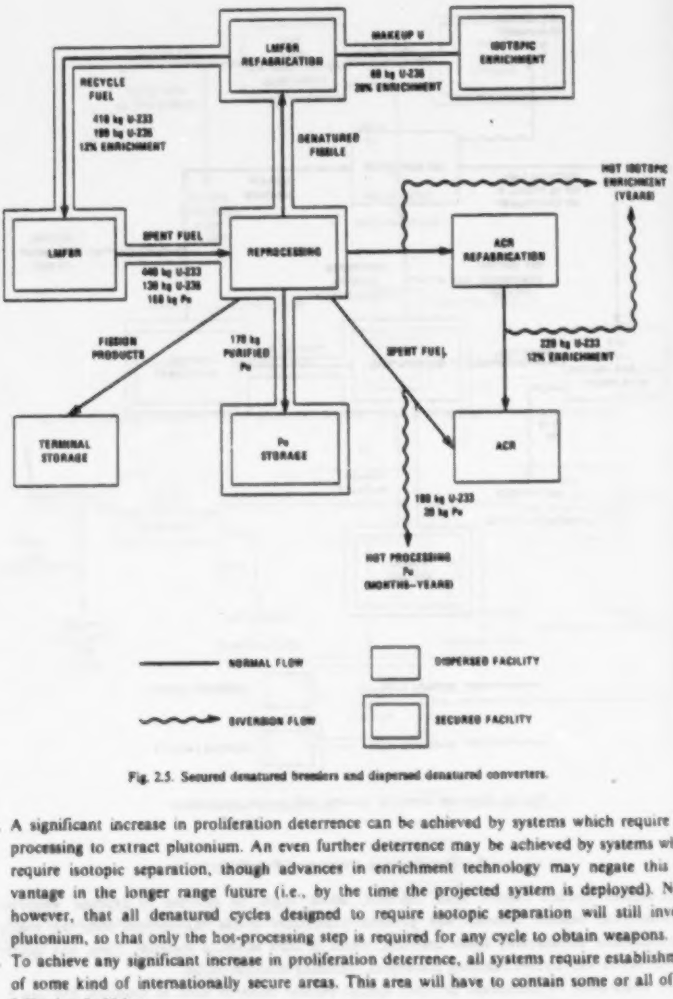
LMFBR REFABRICATION
MAKEUP U
ISOTOPIC ENRICHMENT
60 kg U-235
20% ENRICHMENT
RECYCLE FUEL
410 kg U-233
180 kg U-235
12% ENRICHMENT
DENATURED FISSILE
HOT ISOTOPIC ENRICHMENT (YEARS)
LMFBR
SPENT FUEL
REPROCESSING
ACR REFABRICATION
440 kg U-233
130 kg U-236
150 kg Pu
FISSION PRODUCTS
170 kg PURIFIED Pu
SPENT FUEL
220 kg U-233
12% ENRICHMENT
TERMINAL STORAGE
Pu STORAGE
ACR
180 kg U-233
20 kg Pu
HOT PROCESSING Pu (MONTHS–YEARS)
NORMAL FLOW
DISPERSED FACILITY
DIVERSION FLOW
SECURED FACILITY

Fig. 2.5. Secured denatured breeders and dispersed denatured converters.

3. A significant increase in proliferation deterrence can be achieved by systems which require hot processing to extract plutonium. An even further deterrence may be achieved by systems which require isotopic separation, though advances in enrichment technology may negate this advantage in the longer range future (i.e., by the time the projected system is deployed). Note, however, that all denatured cycles designed to require isotopic separation will still involve plutonium, so that only the hot-processing step is required for any cycle to obtain weapons.
4. To achieve any significant increase in proliferation deterrence, all systems require establishment of some kind of internationally secure areas. This area will have to contain some or all of the following facilities:
   a) spent fuel or disposal,

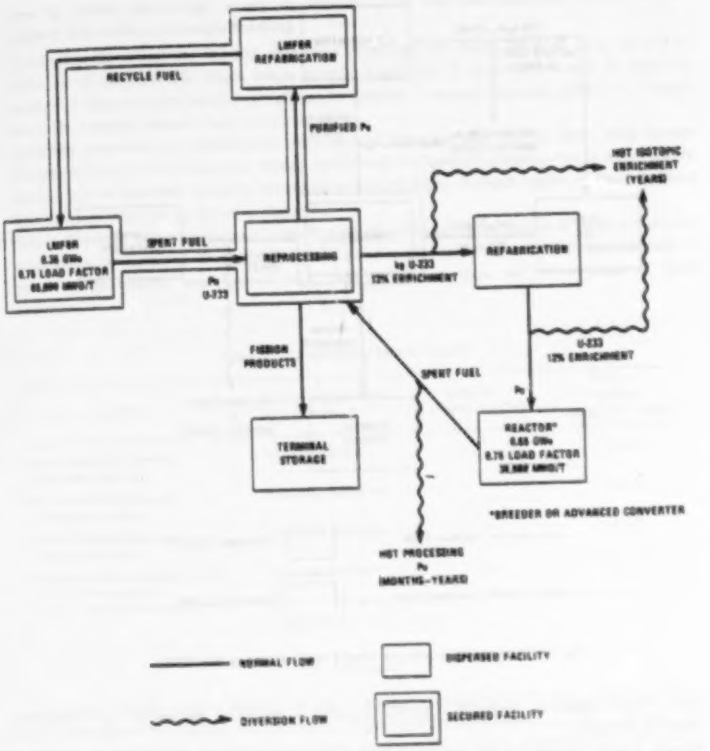
LMFBR
REFABRICATION
RECYCLE FUEL
PURIFIED Pu
HOT ISOTOPIC ENRICHMENT (YEARS)
LMFBR
0.36 GWe
0.75 LOAD FACTOR
65,000 MWD/T
SPENT FUEL
REPROCESSING
Pu
U-233
kg U-233
12% ENRICHMENT
REFABRICATION
FISSION PRODUCTS
U-233
12% ENRICHMENT
SPENT FUEL
Pu
TERMINAL STORAGE
REACTOR*
0.65 GWe
0.75 LOAD FACTOR
30,000 MWD/T
*BREEDER OR ADVANCED CONVERTER
HOT PROCESSING
Pu
(MONTHS–YEARS)
NORMAL FLOW
DISPERSED FACILITY
DIVERSION FLOW
SECURED FACILITY

Fig. 2.6. Secured plutonium-cycle breeders and reprocessing with dispersed denatured reactors (breeders or advanced converters).

b) reprocessing,

c) reactors.

The ease of establishing the secure area may differ between different energy systems, but all energy systems, including throwaway cycles, rely upon establishment of some kind of secure area to achieve a proliferation deterrent.

5. *If an internationally secure area can be established, the different concepts differ only in the amount of weapons material available*. Denaturing can help in achieving smaller plutonium flows in unsecured areas, but even with denaturing there is enough material for several weapons in a single core discharge. Further, the lowest value of plutonium shown in Table 2.1 for the denatured systems requires introduction of heavy-water reactors, which can be used as very

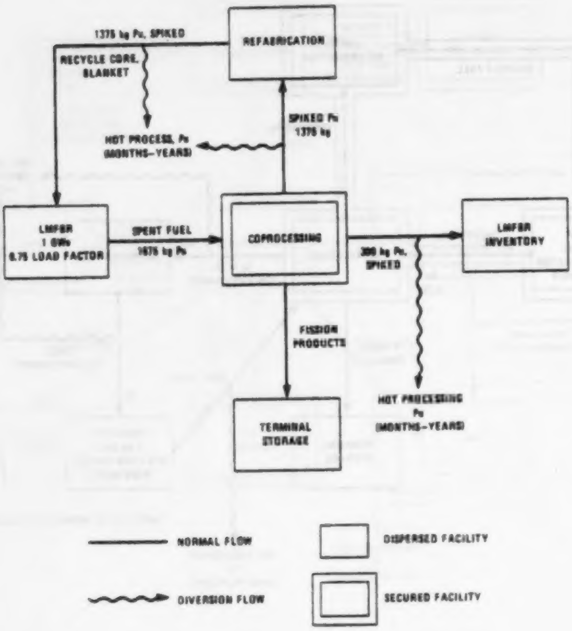
1375 kg Pu, SPIKED
REFABRICATION
RECYCLE CORE, BLANKET
SPIKED Pu 1375 kg
HOT PROCESS, Pu (MONTHS–YEARS)
LMFBR
1 GWe
0.75 LOAD FACTOR
SPENT FUEL
1675 kg Pu
COPROCESSING
300 kg Pu, SPIKED
LMFBR INVENTORY
FISSION PRODUCTS
HOT PROCESSING Pu (MONTHS–YEARS)
TERMINAL STORAGE
NORMAL FLOW
DISPERSED FACILITY
DIVERSION FLOW
SECURED FACILITY

Fig. 2.7. Dispersed plutonium-cycle breeder with coprocessing and spiking.

good weapons-material producers if natural uranium is placed in the reactor by a would-be weapons producer.

6. Breeder reactor systems are not incompatible with nonproliferating nuclear systems. In fact, the inherent flexibility of the breeder system is what allows nonproliferating cycles to operate over the long term. The major difference between systems from a nonproliferation point of view would appear to be the degree of security that can be established in controlled areas through international agreements, not what kind of machine or fuel is used to produce energy.

2.2 Energy Availability

1. Without any recycle capability, no system can make good use of abundant fertile materials; thus the nuclear option is apt to have a very limited duration and cannot offer a long-term energy option to the world.
2. Allowing uranium 233 recycling in the thorium cycle can extend the resource base, but if the uranium resource base is not large, implementation of the thorium cycle may not be possible in

time to increase the energy supply significantly. Note also that denatured thorium recycle schemes still involve plutonium handling.

3. To significantly extend the resource base using denatured fuel cycles, reactors must be able to make use of uranium 238, which means burning plutonium. If plutonium cannot be used, the number of thorium-cycle reactors which can be installed in a timely manner will be very limited unless the uranium resource base is very large.
4. Advanced converters in combination with secured breeders can provide large total energy availability, but a truly long-range energy future with any growth potential can be assured only through use of dispersed breeders, denatured or not. In terms of rough figures of merit, systems with breeders compare as shown in Table 2.2.
5. Only a dispersed breeder economy provides true assurance of energy option if moderate growth areas are to be sustained. Further, dispersed converter economies require significant amounts of power in the secured areas, which may make it hard to meet the power needs of other countries.

Table 2.2. Comparison of breeder systems

System	Total energy available (GW-years)	Long-term growth rate (%)	Time to establish equilibrium (years)
Secured breeder/dispersed advanced converter	40,000–200,000	0	50–70
Secured breeder/dispersed near-unity breeder	Essentially unlimited	0	50–70
Secured breeder/dispersed denatured breeder	Essentially unlimited	2–3	~30–50
Dispersed plutonium breeder with secured reprocessing	Essentially unlimited	5–10	~30–40

2.3 Summary

All nuclear energy systems involve the use of weapons-usable material. Thus, there can be no perfect nonproliferation nuclear energy system. Significant proliferation deterrence, however, can be achieved by establishing internationally secure areas in which readily available weapons material is controlled. If highly secure areas can be established, there is little qualitative difference between alternative reactor types, since enough weapons-usable material will be available from a single reactor to produce several weapons per year for any reactor type. First priority must be given, therefore, to establishing the institutional and international relationships to create secure areas for handling of material with explosive potential. The choice of nuclear energy system concepts to go with the international agreements should be determined primarily by energy potential, economics, safety, and environmental acceptability, since all reactor types can be implemented in nearly equally secure nonproliferation systems.

To provide for any long-term nuclear option, breeder reactors must be part of any nuclear system. Advanced converters and denatured cycles can complement a breeder system but cannot substitute for a breeder. Further, advanced converters cannot long delay the need for a breeder unless a very large uranium supply is *assured*. The most likely international energy system will

7. You question, apparently without having any details of the plan, whether International Plutonium Storage can be constructed in a way which will meet the "timely warning" criterion and still be acceptable to other nations. Without agreeing with that conclusion, even if it ultimately were to prove correct, would it be a worthwhile trade-off to accept a somewhat less rigorous criterion on U.S.-controlled plutonium if in so doing we were able to bring large quantities of plutonium over which we currently have no control under substantially higher levels of safeguards, physical security and controlled use?

8. What interpretation do you place on INFCE's failure to compare and rate proliferation risks of various nuclear fuel cycles?

   What is your assessment of these risks? Why?

9. Assuming nuclear power will continue for the next few decades, what proliferation risks do you see in the once through fuel cycles with perpetual spent fuel storage?

   Where do you think spent nuclear fuel should be stored? Under what conditions?

66-272 189

involve, therefore, both denatured advanced converters and plutonium-cycle breeders, options 4 and 7 of Table 2.1. Other system options either do not provide for a long-range option or requir very large amounts of power to be generated in secured international areas.

To meet our nonproliferation objectives, a high priority must be placed on a mor proliferation-free breeder reactor system that will make the option available in the pre-2000 tim frame. The program must be supplemented by additional work on alternative nuclear system development to meet the needs of nations in which secured energy systems would not be located.

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
SUITE 2321 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, D.C. 20515

June 11, 1980

Dr. Chauncey Starr
Vice Chairman
Electric Power Research Institute
3412 Hillview Avenue
Palo Alto, California 94304

Dear Dr. Starr: Chauncey

Thank you once again for appearing before the Subcommittee on Energy Research and Production during our June 5 hearing on the International Nuclear Fuel Cycle Evaluation study, and the implications for future nuclear energy research and development. We found your testimony particularly insightful and useful, and we sincerely appreciate you sharing your expertise with us.

During the hearing, we indicated that the Subcommittee might request some additional information in the form of further questions. Having reviewed the testimony received at the hearing, we find that additional information would be very helpful. Accordingly, we would appreciate your providing, for the record, responses to the enclosed questions.

Your prompt reply would be most appreciated. Thank you for your cooperation on this matter.

Sincerely,

Mike

MIKE McCORMACK, Chairman
Subcommittee on Energy
Research and Production

MM/Cwm

Enclosure

QUESTIONS FOR
Dr. Chauncey Starr
following
INFCE HEARINGS
June 5, 1980

1. The April issue of the EPRI Journal has an interesting article entitled the "Time Lag of Energy Innovation" in which it is stated that "Bringing a new electric power technology from the laboratory to the point of commercial penetration in the electric utility industry takes roughly 35-45 years". Doesn't this suggest that even if the more optimistic INFCE estimates of uranium availability are accurate, we should be accelerating our LMFBR program rather than reducing it as proposed in the FY 1981 DoE budget?

2. Should the U.S. take a more aggressive role in nuclear R&D programs or should the constraints on industry be adjusted to encourage R&D? What balance between government involvement and control of nuclear R&D and industry freedom do you think is appropriate?

3. What differences in proliferation risks do you see between the conventional plutonium breeder and that breeder with fuel cycles modified so that the fuel materials are more dangerous and difficult to divert or steal? Do you think the benefit to be gained by developing alternative fuel cycles for the plutonium breeder are worth the costs in time, brainpower and public funds?

4. Statements by speakers from every area of the world [at least eight participants] at the final plenary session of INFCE called for the further development and improvement of current safeguards methods and technology (e.g., Australia, Denmark, Canada, Egypt, Japan, Netherlands, Sweden, Euratom).

   As the leading non-proliferation proponent, it would seem that our domestic safeguards R&D programs would be reflected. How do you explain the GAO finding (March 18, 1980) that "the Administration's policy has hampered research and development of ways to safeguard against the diversion of nuclear material"?

   Do you believe that the importance of safeguards has been over emphasized and that in fact GAO's perception is inaccurate, or is the Administration's approach to safeguards simply reflective of an anti-nuclear policy designed to thwart closure of the nuclear fuel cycle?

5. Criticism of INFCE projections of nuclear power growth and a continued lowering of the estimated U.S. growth seem to be based on the assumption of business-as-usual. What relationship do the low projections of the Administration have to the energy needs of the U.S. and abroad?

   What will be the effect if these low projections are realized?

6. You have implied that the decisions which led to the U.S. policies in this area were a matter of political desire not founded on technical facts. What motivated such policies and who was influential in establishing them?

ELECTRIC POWER RESEARCH INSTITUTE

EPRI

June 19, 1980

The Honorable Mike McCormack
Chairman, Subcommittee on
Energy Research and Production
Committee on Science and Technology
U. S. House of Representatives
Suite 2321 - Rayburn House Office Building
Washington, D. C. 20515

Dear Mike:

In response to your letter of June 11, I am enclosing the answers to the list of questions you sent along after my recent testimony on the INFCE study.

Please let me know if there is anything else I can do.

Sincerely,

Chauncey

Chauncey Starr
Vice Chairman

CS:ebn
Enclosure

Headquarters: 3412 Hillview Avenue, Post Office Box 10412, Palo Alto, CA 94303 (415) 855-2000
Washington Office: 1800 Massachusetts Avenue, NW, Suite 700, Washington, DC 20036 (202) 872-9222

QUESTIONS FOR
Dr. Chauncey Starr
following
INFCE HEARINGS
June 5, 1980

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   What will be the effect if these low projections are realized?

6. You have implied that the decisions which led to the U.S. policies in this area were a matter of political desire not founded on technical facts. What motivated such policies and who was influential in establishing them?

ANSWERS TO QUESTIONS FROM THE
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

Following the INFCE Hearings
on June 5, 1980

by Dr. Chauncey Starr

1. That is true. If we wish to develop the LMFBR option to the point where it could be deployed on a large scale during the second decade of the next century, assuming there then is a national decision to do so, then we should start with an LMFBR demonstration program right now. A realistic breeder plant construction schedule, developed by EPRI staff, is shown in Figure 1. As indicated in this figure, even if we start right now, we are not likely to have more than 2 GWe of FBR demonstration plants (2 - 3 reactors) on line by 2010, or 30 years from now. Full-scale commercialization following the engineering demonstration phase will require two more decades, so that if we want the FBR to make an appropriate contribution to our future energy supplies, we should not delay its development any further. The construction schedule of the French LMFBR program is shown in Figure 2. As seen in Figure 2, even with a wholehearted cooperation between the French Government, Atomic Energy Commission, and industry, it will require 35 years to install six commercial breeder reactors. This required cooperation is unfortunately missing in the current U.S. situation, with an attendant impact on the prospects for FBR commercialization.

As for the larger uranium resource estimates of the INFCE program, I should comment that these resources were found only in the government computers and not physically in the ground. There exists a large difference between projecting resource availability and having uranium supply on hand when required.

A study performed by a respected architect engineering company for the INFCE program has indicated that for all nuclear growth forecasts except the lowest, the probability of having adequate uranium supplies by the turn of this century is less than 50 percent.

2. The large undertaking involved in breeder demonstration projects requires a joint government/industry cooperation. This procedure is followed by other national FBR programs, e. g., France, Germany, and Japan. In this country we had the Prototype Large Breeder Reactor (PLBR) study as a model. That project, which involved joint government/utilities (through EPRI) funding, progressed initially on schedule and employed three vendor-A/E teams. With the change in administrations following the 1976 elections, the government participation in this project was unilaterally terminated, leaving the utility sponsors to carry the bill. Another unfortunate example is the government sponsorship, and then rejection, of the Clinch River Breeder Reactor project. In short, government/utility cooperation in the design and demonstration phases of a large-scale technology such as the FBR is essential. Our past experience leads us to believe that the government's role in future projects should be more limited, so as to isolate the demonstration program from the vagaries of the political process.

3. We have known from practical experience gained in such plants as the integral fuel cycle of the EBR-II breeder and others that a complete FBR fuel cycle routinely operated on a short fuel turnaround time would represent a sufficient barrier to materials diversion due to the internal residual radioactivity in the reprocessed and recycled fuel.

   In the absence of such operating fuel cycle, we in EPRI, in cooperation with our British friends, have proposed the CIVEX fuel cycle (for Civilian Extraction as compared with PUREX) as a feasible form of a diversion-resistant fuel cycle. Let me comment right away that several components of the CIVEX cycle (see enclosed Figure 3) would be present in a mature conventional FBR fuel cycle, e.g., co-location of reprocessing and refabrication plants and residual activity in the recycled fuel. Thus, we view the CIVEX concept and a mature FBR fuel cycle as essentially similar in diversion resistance, insofar as could be measured.

We view the CIVEX concept as an intermediate step that would be introduced at the early days of the commercialization of the FBR technology, in order to allay proliferation and diversion worries of new countries about to install this new power generation technology and its related fuel cycle. CIVEX could also be employed in international nuclear commerce if eventually the sale of fuel cycle facilities became an essential part of the FBR export conditions, much as now happens in the LWRs marketing area. Given these benefits, we believe that basic R&D activities in the CIVEX concept should be carried on. However, the more important conclusion we draw is that development and demonstration of all FBR fuel cycle components should be vigorously pursued, so that a complete fuel cycle could be demonstrated by the time the reactor plants are ready for commercialization.

4. I quite agree with the GAO finding that "the Administration's policy has hampered R&D in ways to safeguard against the diversion of nuclear material". The Administration's ostrich-like policy in the area of fuel reprocessing and recycle, which was supposed to "set an example" to other nations, has by now, after the end of the INFCE study, been recognized as a complete failure. The implications for the U.S. R&D effort have been very serious. All activities related to the closure of the back end of the fuel cycle (including safeguards) have been severely cut back and neglected. As a result, the U.S. does not have an internally adequate safeguards system in place, and it is in no position to leverage the development of fuel cycle technologies by other nations which cannot follow the Administration's self-denial policy.

The problem of nuclear proliferation cannot, however, be solved by technical fixes only, as is so clearly demonstrated by the INFCE study. Large-scale evolution of institutional arrangements is required to complement any safeguards measures in place. In this area, the Administration's position of wishing the problem away by avoiding it may cause more permanent damage than in slowing the development of safeguards technology. I refer specifically to the Administration's foot-dragging on the establishment of international plutonium storage under IAEA auspices. It is clear that the subject of international plutonium management must be agreed upon by all interested nations, and most of all by the U.S. Avoiding this subject will not make this issue disappear. I do not believe that all the segments of this Administration are necessarily antinuclear. However, in its obsessive concern with the presumed dangers of the "plutonium economy," the Administration has paralyzed all activities in this area and lost the leverage it hoped to exert.

I assume that the GAO report concentrated mostly on safeguards technology, and dealt only in a secondary way with the equally important institutional problems. These problems and proposed solutions were thoroughly reviewed by the INFCE study participants.

5. The last four years have seen a continuing decline in nuclear growth projections issued by this Administration. The most recent projections specify a nuclear capacity of 200 GWe or less by the end of this century. Should these projections come into being, they may seriously impact our electric energy capability by the end of this century--unless the U.S. remains in a permanent state of economic collapse.

   The recent preliminary projections of the National Electric Reliability Council indicate that the demand for electricity will grow at about 4 percent per year in the next decade, and that generation in 2000 will be at least double the current electric energy production, even with modest economic growth. In order to provide this expected demand, we assume limited retirement of existing oil, gas, or coal-fired capacity will occur over the next 20 years, and that coal plant capacity will more than double from 220 GWe in 1980 to 500-600 GWe by 2000. Under such conditions the required nuclear capacity by the end of this century will be between 200 and 300 GWe. This figure could be higher if the demand for electric energy and old capacity retirement rates are higher than specified above, or if the expansion of new coal-fired capacity is slowed down by environmental or transportation problems. The introduction of electric cars or additional oil supply interruptions from the Middle East may result in a higher demand for nuclear electric capacity than mentioned above.

Conversely, low electricity demand growth rate or very large expansion of coal mining capacity (to four times the current production rate) would inhibit the growth of nuclear power until the end of this century.

We should recognize, however, that additional load growth can be expected in the next century, which can be provided only by technologies being developed today. By 2010 all the existing 550 GWe of electric capacity will be at least 30 years old, and a large fraction of this capacity will have to be replaced. Nuclear power represents the only electric baseload technology relatively unencumbered by fuel supply considerations which could be expanded on a massive scale, in order to avoid future electric capacity shortages. The low-capacity projections of this Administration represent a minimum. It should be remembered that 10 years ago, nobody would have projected the spectacular growth of the French nuclear program, which could be the second largest nuclear nation following the U.S.

6. The effective antinuclear policies followed by the current Administration were initiated by the combined action of three separate interest groups: the antinuclear and antigrowth activists, who view nuclear power as the epitome of all that is wrong and evil in our society; arms control theoreticians, who conjured the threat of the plutonium economy; and the inexperienced recent members of the Administration, who sincerely believe in setting moral examples and in the imminent dangers of nuclear proliferation. The professional antinuclear elements have been the most skillful in raising several bogus issues in the attempt to sway the other groups into supporting policies which would enhance the specific aims of the antinuclear movement. Such issues were the unlimited

availability of uranium supplies; the potential of thorium-based denatured fuel cycles as technical fixes to diversion; the early availability of advanced converted reactors, or even of fission-fusion devices as counterweights to the FBR; and the presumed ease of stealing fissile materials and constructing nuclear weapons in the basement. Most of these "straw men" have been put in the proper perspective in study after study, such as the NASAP and INFCE exercises. They did result in slowing the evolution of nuclear power until each subject was properly considered, evaluated, and rejected. Most of the issues raised over the last four years have been studied and discarded by the technical community years ago. The usefulness of the process of reevaluation was in providing technical education to the new members of this Administration, although there is little evidence that their initial anti-nuclear bias has been reduced. Whether this result was worth the economic cost to this country in slowing down the utilization of nuclear power within our energy system, only time will tell.

Mr. McCormack. Thank you, Dr. Starr, for an extraordinarily concise statement. I very much appreciate it, and I'm sure the other members of the committee who will read it in the future will also appreciate it. I have several specific questions I should like to ask you. You mentioned the ease with which many countries could make a few nuclear weapons. Would you care to estimate the cost and the time required for a medium-sized nonnuclear nation to make a half dozen or a dozen small nuclear weapons?

Dr. Starr. Well, of course, it is the first one that takes the time. The subsequent ones come easier. But let's take a country which is halfway up the development scale. I won't give any names particularly, but those that have an internal engineering infrastructure, have some engineering universities, have professional engineers who have been educated, say, in the United States, at MIT, CalTech, or any other engineering school—and some of them have worked in our national labs. And there must be dozens of such countries in the world. My guess is that within a year's time, and for less than $100 million, they could build up the basic facilities to make enough material and to handle it and separate it out, whether they used an enrichment process or whether they used reactors.

Now, once the process is built and the facility is built, then it's a matter of scale. It might take a second year to get enough material for one weapon. It could take less than that. It depends on the scale at which they build. As you know, the origin of India's weapon material was a research reactor development program. Again, it depends on how much you want to do and how fast you want to do it. But with a few years and $100 million, it could be done. I will reverse the question. If I were asked to put together a team of people that I could select in the United States to do something like this in a hurry, just having available the world commercial equipment, I would certainly in 2 years' time have enough material for a weapon.

Mr. McCormack. And at about $100 million, do you think?

Dr. Starr. About $100 million.

Mr. McCormack. So what you are saying is there are several dozen nations in the world today that could within 2 years and for about $100 million produce a half dozen to a dozen small nuclear weapons.

Dr. Starr. I say that would be the first one. After that it depends on the scale. It could take a few years after that to build the next one or the one after that. I'm talking about the material. Now the weapons are a different story. As a matter of fact, one of the things that come out of the 1946 study was that the big obstacle that people would face would be the obstacle of making a successful weapon.

That happens to be a more delicate art than making weapons material. There are many people who can do this, however. In fact the Smyth report, as you might recall, described very elementary ways of doing that. In a few attempts, with a few good scientific people working on it, they could probably get some modest success. But the building and testing of the weapon is a different program from getting the weapons material.

Mr. McCormack. How long would it take for an average—for a modest-sized nation with modest industrial technical capability to make a few weapons?

Dr. STARR. Again, I would say maybe 3 or 4 years to have a few weapons, just as a round number. Again, if I had to do it in the United States, starting from scratch, 3 years would be ample to have the first weapon ready for demonstration.

Mr. WYDLER. How long did it take Israel to build its bomb?

Dr. STARR. I'm in no position to tell you whether Israel has a weapon.

Mr. WYDLER. Everybody assumes it is so. They don't talk about it much, like it doesn't really exist, but we all know it does.

Dr. STARR. I presume the value of the Israeli weapon is greater if it is a presumption than if it is demonstrated.

Mr. MCCORMACK. If we can summarize this point, because I want it for the record: What you are saying is that the average medium-sized country with a modest industrial competence could within 3 or 4 years, and several hundred million dollars produce a few small, modest nuclear weapons?

Dr. STARR. Right.

Mr. MCCORMACK. OK, fine.

Now I would like to switch over just for a moment to a couple of other points that have been made in the past. One of them has to do with the reprocessing of spent fuel. The testimony that we received from the administration simply says INFCE concluded that reprocessing of fuel may or may not be economical, therefore, we completely eliminate that argument and assume that the economic area of reprocessing is not worthy of consideration; would you comment on that?

Dr. STARR. I pointed out in my formal testimony that once the political posture of the administration was taken in 1977, everyone in the administration then was in a position of having to sustain it. You can make an argument, if you take the extremes of uncertainty about all the factors, that you could defer the development of reprocessing for recycle and light water reactors and you could defer development of the breeder. You have to take extreme assumptions.

Now, the reason you can do this is that there hasn't been a commercial reprocessing cycle in operation long enough so that anyone knows what the real costs are. There are always paper projections, and in paper projections you can take high or low or intermediate costs. The administration has taken very high projections. There are several factors that go into this. One is the cost of the facilities of the reprocessing cycle. The second is the cost of enriched uranium. Both of these are tradeoff variables, because the issue is whether plutonium is worthwhile recycling as a fuel. The answer is we don't know the answer.

If the cost of enrichment and the cost of uranium go up, and there is available experience on recycling through chemical processes so that its cost goes down, then somewhere along the line the two cross over from an economic point of view. But there may be other reasons why nations may want to go into reprocessing. One is energy independence. If you have, as all the testimony before you will indicate, stored spent fuel with a large amount of unburned enriched uranium and a large amount of plutonium sitting there as a fuel, and you are importing fuel from somewhere else, you may want, for reasons of national policy and national economics to get it out.

In this country what was sought when we urged the chemical reprocessing program and the fast breeder program was the development of the option to be able to do both of these things, and to get the experience that would give us better cost factors. Nobody in this country said that we were ready for deployment. Nobody in the nuclear industry urged deployment of fast reactors or the deployment of recycling and chemical reprocessing. What was asked for and what was underway, before this administration cut it off, was the development of the option and the experience to answer your question.

Mr. McCormack. One more question, if I may. You have stated that we must do something with the time that we are spending. I would like to ask you about a few potential options and if you would say they contribute to reducing or in any way modifying the potential for weapons proliferation. The first would be going ahead with the Clinch River or a similar liquid metal fast breeder demonstration facility. Does that influence in any way the potential for proliferation?

Dr. Starr. The answer to that is yes in two different ways. One is from a purely technological point of view. I mentioned that the surest way to keep the total amount of loose plutonium in the world down is to use it, and I feel very strongly that the major nuclear powers should look upon the fast breeder as part of the equipment that they have to absorb the plutonium production that comes not only from their own machines, but machines from elsewhere in the world.

The second reason, however, is a more subtle one. As a result of what this administration has done, we have destroyed the appearance of the United States as being the technological leader in the nuclear field. Our technical professionals are no longer a party to the international discussion that goes on in the development of advanced nuclear technologies. There was a time before this administration took over when most of the senior technical people in this country were informally involved in guiding and helping other countries in developing their technologies, in exchange for which we found out what they were doing. We no longer have that contact, and we no longer have that influence.

We are looked at internationally as a second-rate nuclear power in nuclear technology, and the Clinch River program or any equivalent fast breeder program would help to reestablish our ability to negotiate with the rest of the world in nuclear technology exchanges. I think that we have got to somehow reestablish the leadership of the United States as a constructive nation in nuclear power. And this would be a big step.

Mr. McCormack. How would you rate then the establishment of a multinational fuel recycling center at Barnwell?

Dr. Starr. I think this would be a good step. One of the things that unfortunately has been a consequence of the U.S. policies in the last several years has been the destruction of the image of the United States as a reliable supplier and partner in the nuclear business. Anything we can do to indicate that we have some real willingness to help other nations in the development of peaceful nuclear power would, I think, be a step in the direction of reestablishing the U.S. position in this field. Certainly, aside from our own learning that we would get in a Barnwell reprocessing center, the establishment of an international position for the United States in reprocessing technology would be an extremely important contribution.

Mr. McCormack. Thank you.

Mr. Wydler.?

Mr. WYDLER. Maybe you will help me a little bit, Dr. Starr, as a layman here. I'm trying to relate what you just told us about how a rather small country could build a nuclear weapon right now, with a very small amount of money involved in a fairly short period of time. Now the administration apparently was worried about the introduction of a large amount of plutonium into the future of the world. We were talking about breeders, and the way I understood it that was going to take us 15 or 20 years into the future before we would really have anything breeding. But assuming that did come about and there was a relatively larger amount of plutonium available than there is now, how would that have helped one of these countries to build an atomic weapon?

Dr. STARR. Well, if a country had a completely closed internal system for nuclear power that included chemical reprocessing, then there is no question that that country could make a decision at some point to bleed off some of that plutonium at the end of its chemical purification cycle and divert that for weapons use. That was the position that the administration used for justifying its whole approach.

Mr. WYDLER. I realize that, but what I'm trying to get clear in my own mind is how does it change what you told us before? In other words, they could do it in 3 or 4 years with $100 million. They could do it now without plutonium.

Now we bring plutonium into it, how long would it take them and how much would it cost them?

Dr. STARR. To get the weapons material, if they were bleeding it off of an internal chemical reprocessing plant of the kind we have now, would be easy. They could do that any time. To develop the weapon would be a lengthy process itself. It might give you, maybe, 6 months or a year's delay, depending upon when they started their weapon's development.

But let me come back to this point: Many of us, myself included, have urged for years that the economics of chemical reprocessing would justify international centers under international control as one step to make it difficult for any one country to divert from the end point of a chemical plant.

The second proposal, which many have made and which is completely feasible technically, is to set up the industrial chemical process, so that what comes out of the chemical plant and goes into new fuel is just as difficult to make into weapons plutonium as if you started with spent fuel.

You see, every nuclear power station will give you spent fuel. The issue really is what do you do with that? Do you put it into chemical processing or do you put it into storage? I have given many talks and many papers on the fact that probably the biggest hazard to the world in terms of potential diversion is just to store spent fuel indefinitely. It becomes a mine of easily accessible plutonium, and that process is very easy. That's a matter of months. If I had to do it in this country, I could do it in weeks, to take spent fuel that is say 5 years old and extract the plutonium.

So the problem is that if you are going to have nuclear power systems, you want to do one of two things: either get the spent fuel out of country X into some international center, where it is under international control; or set up an industrial chemical reprocessing system, which, by its very nature, is a hardened system in principle. When such material comes out, it would be good for fuel but not for weapons. And that can be done, and we have written professional papers on that too.

Mr. **Wydler.** I appreciate what you are saying, but I am trying to think this through from the point of view of what the administration is trying to tell us. And what they are trying to tell us is that there are countries in the world somewhere that won't build a nuclear weapon now because they don't want to spend $100 million and take 3 or 4 years of effort, but if there is plutonium available in the world, then they want to build one. That's what they are telling us. Because they can do it either way and they certainly would take the cheapest and easiest way.

I find that to be an inconceivable concept, that if there are countries that really wanted a nuclear weapon they wouldn't go out and build one under the present circumstances that exist. It is a relatively quick and cheap thing to do. But if there is plutonium available in the world, then they would want to build an atomic weapon because it is there. I just don't find any logic in that.

Dr. **Starr.** The concern is one of degree. If I had to argue the administration's position on that point, I could make a good case for it.

If you set up—I will repeat again, because I am choosing my words carefully on this—if you set up a closed nuclear system in any country, that is, one which makes its fuel, has nuclear power stations, reprocesses, and ends up with pure plutonium somewhere at the end point, and feeds that back for fuel purposes either into fast reactors or recycle, and if overnight there is a military coup and General Y decides he wants a weapon, the weapons material is there, and he can divert it from the power cycle for that purpose. If he makes such an overnight decision, it may still take him a year or more to get a demonstrated weapon. But the material is there, and that certainly is a situation I would like to see avoided.

Mr. **Wydler.** But the point I am trying to make is, if General Y does the coup and he does have the plutonium, he can still make the decision we're going to get an atomic weapon.

Dr. **Starr.** That is the case, as you know from reading the newspapers, that has everybody concerned about Pakistan. We've got examples all over the world where some of these things are rumored to be going on. Pakistan doesn't have a nuclear power system, and yet there are people concerned about Pakistan getting a weapon soon. Whether they will or not, I don't know, but I understand the steps they are going through, and it is not out of reason—if they want to, they can get it. The point is there is a time element. There is an early warning element. There are many factors that go into this.

The only way you can stop the proliferation of nuclear weapons throughout the world, regardless of whether you have nuclear power or not, is by international diplomatic means. There will be early warning signals of all kinds. If there is no international response, these people will go right ahead. You are going to hear more about it this afternoon, from people who have studied this in some detail. But the fact is that that position is correct.

But it doesn't have to be that way. That is the point which many of us who feel that nuclear power is inevitable feel must be addressed; namely, it doesn't have to be that every country has its own chemical reprocessing plant. It doesn't have to be that whatever chemical reprocessing plants exist will give you pure plutonium that can go into weapons. The two things you can do are to put international control in certain major centers for the chemical reprocessing, so that there are multinational groups running those things; and, second, the plant does not have to make pure plutonium which is what we do now, because all of our plants now originally were designed for weapons purposes. The plants can make material that is completely adequate for fuel for both fast reactors and light water reactor recycle but which is sufficiently hardened in a radioactive self-protective sense, that it would be a big effort for anyone to try to get weapons material out of it, just as big as if one took spent fuel.

Let me just point out the alternatives. If you are going to have nuclear power, you will have spent fuel. If country X has no chemical reprocessing plant today, and just stores that for 5 years or more, and makes the decision that it wants to go into the weapons business, they can do it very rapidly.

As I said, in a matter of months in this country we could certainly separate out the plutonium for weapons from spent fuel. So the issue of a chemical reprocessing plant is really one of whether it is going to take you a couple of months, or there's an overnight decision, or there is international control, or the plant is designed to be hardened, so it takes just as long to do that as if you were handling spent fuel. And all these things are feasible.

Mr. McCormack. I'm going to ask Mr. Wydler to continue with the meeting and I will excuse myself.

Mr. Wydler. Since I'm not running again, I don't worry about making these quorum calls to prove that I am here. But the chairman doesn't have the luxury of that situation right now.

Really, your testimony here today has been superb and stimulating and very helpful to me and I am sure to the committee members in helping us understand where we are.

I wonder if you would be willing—it is the last question I have and totally out of order, so if you don't want to deal with it much, you can slough it off. But I would like to have your views on the Nonproliferation Act that the Congress passed and what it has done to us or for us in the world, because personally I have come to the conclusion that that act has to be reviewed by the Congress—I don't want to put words in your mouth—are you willing at this time to say on the record anything regarding it?

Dr. Starr. Let me say something about the original Non-Proliferation Treaty which over 100 nations signed. That represented a U.S. policy effort of many, many years. It was extraordinarily successful. It was basically a simple treaty. What it said was that in return for the United States making available to the nations of the world the know-how on civilian nuclear power, and the support of their development of civilian nuclear power, these nations would give up the concept of developing their own nuclear weapons. There was a real tradeoff, which was amazingly successful, because none of the signatories of that treaty, as far as I know, have violated it.

That treaty has been almost thrown into the wastebasket by this administration by essentially destroying our part of the bargain, the support of other nation's civilian power programs. We've hemmed; we've hawed; we've put in all kinds of unilateral restrictions. I don't think anyone now outside the United States is going to pay much attention to anything that comes out of the United States in terms of a new treaty proposal. They are not going to believe us. When you do business with somebody who cheats you, that's an unfortunate circumstance. If you continue to do business with them you are a fool—and I don't think the nations of the world are fools.

I think we have a terrible situation to overcome now of reestablishing the credibility of anything we offer to do. The fact that we were willing to unilaterally step back from what was a successful effort in order to place boundaries on other nations' development of nuclear weapons was I think a gross mistake on the part of the United States, and from my point of view, a very dishonorable thing. I don't know if that answers your question.

Mr. WYDLER. It does and I appreciate very much your being so candid. And I appreciate your testimony as I said, Dr. Starr. And if there are no other questions, we will excuse you.

Our next witness is Mr. John Kearney, senior vice president of the Edison Electric Institute, the national association of the investor-owned segment of the utility industry. Mr. Kearney will be speaking as a representative of the electric utility industry on the implications of INFCE, and we look forward to hearing your testimony.

Go ahead, and we are delighted to have you with us today.

STATEMENT OF JOHN KEARNEY, SENIOR VICE PRESIDENT, EDISON ELECTRIC INSTITUTE

Mr. KEARNEY. Thank you. In line with the chairman's request, I am going to summarize my statement.

What I have tried to do, Mr. Wydler, is briefly review in the paper where we were before the changes made by the present administration, what have been the results of the INFCE study as they impact on the domestic utility industry and then lastly to give some views on how we think the R. & D. program of the Federal Government can complement what we have learned from INFCE. One point I would like to make initially is that we are certainly concerned about nuclear weapons proliferation as good citizens, but we recognize also that there is an essential need for nuclear power and somehow there has to be a balance between these two objectives. We think we can obtain such a balance in the international scene.

As you know, prior to 1976, the game plan of the U.S. utility nuclear program was to build light water reactors as well as depend a little on high temperature gas reactors. Then we anticipated at some point in time that these reactors would be followed on by the liquid metal fast breeder reactor. The reason for that is, as Dr. Starr has pointed out, there are tremendous energy equivalents in spent fuel. About half of the value of the fuel, the fresh fuel, is contained in the spent fuel in the plutonium and unused uranium.

It just seems inconceivable, both from a national point of view and from the world point of view, that at this time when we are facing major confrontations about the use of available energy resources that we don't have the will and don't make the effort, both domestically and internationally, to develop a safe way of using these concentrated energy resources.

We think the INFCE study has reinforced the position that adequate safeguards can be implemented to permit us to use breeder reactors.

Now, as you know, our game plan was changed substantially with the change in policy of the present administration. With proliferation being the predominating driving force, a Presidential directive ended up in deferring commercial reprocessing of spent fuel, cancelling the Clinch River breeder reactor and even subsequently this year decreasing research and development on breeder technology.

As an aside, we certainly appreciate the work of this committee in trying to restore the base breeder program in the DOE budget.

Mr. **Wydler**. I hate to interrupt you, but as you are putting those things in historical context, it really is amazing that those steps were taken at a time of great crisis in our country in the energy field. When we were most needing of new technology and new fuel sources, we just took one of the most promising of them all and decided we were going to abandon it. When thought of in those terms, it becomes an almost unbelievable decision that was made.

In particular, I am talking about the timeframe in which it was made. If we had been in a very generous oil-supply situation with no world problems and cheap oil, you might be able to understand it. But here we are thrashing around talking about trying to develop energy sources at the fringe. We are having hearings down here on ocean thermal systems. That's a very great concept. And the fusion people have great ideas of something that might work, but it is quite far away and quite far out and so on.

All of these things we are thrashing around trying to get something out of and here is one that we know practically assuredly will work. We know it works as a matter of fact. And we simply abandon it. I'm sorry to interrupt.

Mr. **Kearney**. That's all right. I share your bewilderment. But just looking at it from the point of view of this driving force of being concerned about proliferation, even if you take that as an objective, we think that the policies of the administration are deficient, because as Dr. Starr has pointed out, we are no longer in on the development of things internationally; we just can't stick our head in the sand if we are going to proceed and try to solve this problem of proliferation. We are looking from the outside at this moment. From the domestic utilities' point of view it has caused us a problem with spent fuel. We are going to run out of space at reactor sites and we are going to have to store it someplace.

We don't have the opportunity to decide if thermal recycle is an option. Last, it has delayed the development of the breeder which ultimately we feel is necessary for both this country and abroad.

Now as far as the INFCE results are concerned, I have got my copy right here and it is underlined, and I could take all the good things out of here and quote them to you. And I'm sure if somebody who was antinuclear had his copy he wouldn't have the same things underlined, but he would have other things underlined.

pages tightly bound

However, I think the bottom line of looking at this is that it really hasn't changed the approach we had in mind. For example, the INFCE study didn't reveal that one nuclear system——

Mr. WYDLER. There is a vote on and I have a sinking feeling it will be one of these 5-minute votes. If it is, I'm going to have to run out of here. Otherwise, we have 5 minutes left.

Mr. KEARNEY. I was going to say that I think the significant thing that came out of INFCE was that it revealed that there was no one nuclear system or approach that was superior to any others in the long term and as far as alternative advanced systems, that is, different from the breeder are concerned, INFCE concluded that none of them could be available until well after the year 2000. And even more importantly, they didn't offer any significant advantages as far as proliferation is concerned, which was one of the main reasons for this study.

Also, INFCE did create a greater awareness of the sensitivity of the aspects of the different types of fuel cycle and it did identify some technical fixes that we could use. But basically it came to the conclusion that the main proliferation resistance is going to be institutional means. There is no magic special cycle. So therefore, as far as we are concerned—the domestic utility industry—we think it more or less confirms the road that we were on before; that is, the light water reactor followed on eventually by breeder technology.

So that really, as far as the question of breeder technology is concerned, what we want to do is develop that option so that we can have the ability to deploy it when we need it in the future. There is no reason to get into arguments about when that magic date is, because it is going to happen. As far as international participation is concerned, I am sure you are going to hear from others on that. But it is quite obvious to us that the United States has to become active in developing these institutional arrangements, and as far as our commercial companies are concerned, if they are not a party to the development and marketing, both domestically and internationally of nuclear power that is geared to this proliferation resistance, then it is going to impact on the domestic utilities because we will not have a strong nuclear industry in this country. So that while we are not directly involved I think we are indirectly concerned about what happens as far as the international market is concerned.

Now, last, in the paper we suggest some directions for research and development as had been requested of us. What I have listed is some of the things that come out of INFCE and how they are going to impact on what we ought to be doing in research and development. I won't read them all, but I just want to read one. The availability of nuclear power—this is sort of INFCE speaking—is a right of any nation. And it is obvious that many nations are going to proceed with nuclear power, with or without the help of the United States. So we are either going to be a party to nuclear development and try to develop it along the right ways or we are going to be looking from the outside in.

Specifically though, and I shall read from my statement, we think that the U.S. research and development efforts taking into account the INFCE study ought to be giving guidance to the following: overall nuclear safeguards, interim storage of spent fuel, reprocessing of commercial spent fuel, recycle of uranium and plutonium fuels and thermal cycles, plutonium storage, breeder reactor research, development and demonstration. Those are some of the things that we think as a result of INFCE the U.S. Government research and developmen program ought to be looking at. I thank you.

[The prepared statement and additional Q's and A's asked of Mr Kearney follow:]

EDISON ELECTRIC INSTITUTE

Statement on

International Nuclear Fuel Cycle Evaluation

Before the Subcommittee on Energy Research and Production

United States House of Representatives

June 5, 1980

My name is John J. Kearney. I am a Senior Vice President of the Edison Electric Institute; the national association of the investor-owned segment of the electric utility industry. Its members provide about 78 percent of the nation's electricity and serve approximately 67 million electricity customers. We appreciate the opportunity to appear before your subcommittee and present the views of the Institute with regard to the impact of the International Nuclear Fuel Cycle Evaluation (INFCE) on the U.S. commercial nuclear power industry.

I would like to first review briefly the pre-1976 domestic utility industry approach on nuclear power; then address the influence of the present Administration; the results of INFCE; how these results impact the domestic utility consideration; and finally provide views on how the Federal nuclear programs should proceed in a manner that is complementary and compatible with the international directions implicit in the INFCE reports.

INFCE came about solely because of the concern about nuclear weapons proliferation. Domestic utilities support fully the basic concept of minimizing the potential for nuclear weapons proliferation. This is a real concern that must be addressed and resolved. At the same time, however, we recognize the essential need to use nuclear power to satisfy a portion of the world's energy requirements in the foreseeable future. There must be, and can be, a realistic balance between these objectives.

Domestic Electric Utility Nuclear Plans

Over the past three decades domestic utilities have relied upon nuclear power in their expansion programs to assure a reliable and economical supply of electricity for their customers. Today, only coal and nuclear power are available as choices for significant quantities of additional electricity production. A reasonable balance of both must be added to provide the assured supply.

Prior to 1976, a reasonably well defined approach for the effective use of nuclear power included a plan to achieve, by the year 2000, a balance of approximately 50 percent nuclear and 50 percent coal for the production of electricity. The utility nuclear programs called for extensive use of light water reactors as the primary reactor technology as well as the use of high temperature gas cooled reactor technology. This was to be followed by the introduction of liquid metal fast breeder reactors as the nation's uranium resource was consumed.

Since spent fuel from thermal reactors contains energy values in the form of unused uranium and plutonium equivalent to nearly one-half of the energy value of the fresh fuel, the recovery and use of the energy values has always been considered a major nuclear fuel conservation measure. Thus, reprocessing and fuel recycle were believed to be natural segments of the light water reactor nuclear program. In the case of breeders, these steps are essential.

The recoverable energy value in each metric ton of spent fuel for recycle in light water reactors is equivalent to approximately 127,000 barrels of oil when both the recovered uranium and plutonium are used to produce electricity. The INFCE report indicates that about 300,000 metric tons of spent fuel will be discharged from thermal reactors by the year 2000, and this will have an energy equivalent of about 38 billion barrels of oil when recycled in thermal reactors. It is inconceivable that a world facing major confrontation over the availability of energy resources would not proceed with developing a safe way to use this concentrated energy resource. The need for appropriate safeguarding of sensitive operations and nuclear materials has been fully recognized as essential in any attempt to recover these energy values. The INFCE study reinforces the position that adequate safeguards can be implemented to permit this energy conservation program.

Administration Policy Change in 1977

This nation's overall nuclear program took a dramatic change in 1977 as a result of President Carter's new policies. Concern over proliferation became the predominant driving force with Presidential directives taken to indefinitely defer commercial reprocessing of spent fuel, to cancel the Clinch River Breeder Reactor, and subsequently to decrease the research and development of breeder technology. Also, INFCE was conceived of by the Administration in 1977 as a mechanism to foster this dramatic policy change in the U.S. nuclear programs onto the international scene. The domestic utility industry, while standing firmly behind the need to minimize proliferation, believes that President Carter's policies on nuclear power are deficient with regard to the future energy needs of the nation and may even be detrimental to the overall goal of minimizing nuclear weapons proliferation. Only by actively participating in the development of effective safeguards around sensitive aspects of the nuclear program can effective proliferation control be achieved. Sticking one's head in the sand to hide while others proceed is the worst way to control proliferation

INFCE Results

The overall INFCE effort and its product are phenomenal in scope and in breadth of participation. Its 20,000 pages of documents, prepared by over 500 international experts, reviewed 22 reactor types and their fuel cycles. To have a manageable study, five nuclear systems, those most likely to be available, were evaluated in detail.

The carefully worded results of the INFCE effort reveal no one nuclear reactor system or approach to be superior to others over the long term. While in the short-term, the sensitive steps of uranium enrichment and plutonium separation during reprocessing offer potential avenues for proliferation, both are considered necessary steps in the nuclear programs of several countries. Natural uranium is a limited resource and is not uniformly available in all nations. The once-through reactor systems will, at some point, result in uranium resource limitations much like the present oil resource limitations. A combination of thermal reactor recycle and breeder reactors can effectively remove this limit.

We concur with the INFCE acknowledged fact that the efficiency of uranium utilization may be improved by about 15 percent even for once-through fuel approaches. However, the INFCE results recognize that this pales into insignificance when compared to the uranium utilization increase of several orders of magnitude achievable through breeder reactors. The question is not whether reprocessing and breeder reactors should be used but rather when will uranium limitations force their use and under what safeguards control.

As for alternative advanced reactor systems, INFCE found that none could be available until well after the year 2000 and even then they would not offer significant, if any, proliferation advantages. Only through the use of fast breeders with adequate breeding gain can nuclear power be provided, for all practical purposes, free from the limited uranium supply. While the world's uranium supply may take us beyond the turn of the century, the resource is limited to a few decades for all approaches except fast breeder reactors.

INFCE provided a greater awareness of the sensitive aspects of several elements in the nuclear programs and identified a few technical fixes that may decrease the risk of proliferation. No easy solution, however, was found and technical fixes alone were determined to be unsatisfactory in resolving all of the concerns. Institutional arrangements must be developed and implemented.

Thus, a shift in the debate should be away from the defining and assessing of proliferation risks of various nuclear technologies to developing the ability, both technically and institutionally, of using nuclear power in a way that will be within acceptable risk limits.

Future Domestic Utility Nuclear Programs

The INFCE program provided a detailed review of the technical aspects of the many variations of nuclear power and confirmed that the basic commercial approach planned by the U.S. electric utility industry of using low enriched uranium fueled thermal reactors followed by plutonium fueled fast breeder reactors is an appropriate approach. No preferable alternative to this approach is readily apparent from either economic or proliferation control aspects.

INFCE suggests that plutonium will at some time in the future be recovered from spent fuel and used in breeder reactors and possibly recycled in thermal reactors. Spent fuel is a legitimate national and international energy resource.

Commercial nuclear power programs are expected to evolve over the next several decades beyond the use of thermal reactors to the use of breeder reactors with some combination of thermal and breeder reactors in a symbiotic balance to provide an assured supply of fuel. Such a direction is considered to be a reasonable international approach by INFCE. While there is some question about the timing of the need to commercialize breeder reactors or thermal reactor recycle, these options must be developed and available for deployment when uranium resource limitations are encountered.

Breeder Reactor Commercialization

The timing of the need for the implementation of breeder reactors is simply undefinable at this stage. Primary influencing factors include the changing world oil situation, the electrical growth rate, the environmental constraints of coal and nuclear power, the need for a diversified fuel supply, and the amount of economical natural uranium. The range of these factors is so great that useful planning must be based on a conservative approach that fosters early research, development and demonstration with a built-in ability to adjust the actual time of commercialization. The time period required to build nuclear power plants has reached 12 years and longer for units that are essentially duplicates of operating commercial plants. When a realistic lead time of 20 years is added for the development, demonstration and prototype programs plus a ten-year prototype operating experience period to achieve reasonable acceptance, the overall time for achieving a significant commercial penetration of a technology, such as breeder reactors, is viewed to be in the range of 30 to 40 years. There is no feasible way that we could achieve the production of significant quantities of electricity from breeder reactors by the year 2000. In fact, this can only be achieved within the first 20 years of the next century by pursuing a well ordered and continuous breeder research, development and demonstration program.

International Participation

In order to achieve a more effective influence over the control of nuclear technologies and nuclear materials around the world, the U.S. must participate actively in the development of effective institutional arrangements and encourage U.S. commercial nuclear companies to aggressively provide equipment, technology and services that will achieve the desired proliferation control. This international effort is outside the span of activity of domestic electric utilities but it does fall at the front doorstep of their major suppliers. If U.S. commerical nuclear companies are discouraged from developing and offering systems to serve either the domestic or international needs, then foreign countries undoubtedly will fill this gap. Without a developed domestic capability, even the domestic utilities may be forced to turn to foreign suppliers that will have performed the extensive technology improvements for future systems. Such a fate leaves considerable doubt about whether the Administration's approach to improving proliferation control would achieve the desired results.

Directions For RD&D

Since INFCE concluded that the present safeguard systems are generally capable of providing effective international safeguarding of existing reprocessing plants and that improved techniques can be provided to enable effective safeguarding of future commercial plutonium breeder reactors, reprocessing plants and fuel fabrication facilities at an acceptable cost, then the U.S. directions should be compatible with this conclusion. INFCE recognized that technical fixes have an influence in reducing the risk of theft, but only a limited influence in reducing the risk of proliferation. The institutional safeguard measures are judged to be more important than the technical measures. However, improvements in safeguards should be pursued on all fronts on a continuing basis.

Congress should require that DOE proceed with an active RD&D program for the long-range use of nuclear power with an eye toward implementing the best achievable safeguards systems. The direction of these RD&D efforts should recognize the following basic elements that have been confirmed by the INFCE efforts.

- The availability of nuclear power is a right of any nation, and many nations will proceed with nuclear power, with or without U.S. support or participation.
- The world's uranium resource is limited and unevenly distributed among nations.
- There is a strong desire to achieve nuclear fuel independence within the developed nations.
- Commercial spent fuel and enrichment process by-product uranium are major energy resources.
- Alternative advanced nuclear systems provide only incremental advantages for uranium resource utilization and provide no significant proliferation advantages.

- Breeder reactors with adequate breeding gain are essential for long term use of nuclear power to most efficiently use the world's uranium resource.
- Breeder reactors can provide nuclear fuel independence.
- Improvements are desired for international safeguards and this is best achieved by actively developing the technology and participating with the international community in making the improvements.

Current RD&D efforts must recognize the world's need as well as our nation's need for nuclear power. The U.S. RD&D efforts should include programs that will provide domestic and international guidance for the following items:

- overall nuclear safeguards
- interim storage of spent fuel
- reprocessing of commercial spent fuel
- recycle of uranium/plutonium fuels in thermal reactors
- plutonium storage
- breeder reactor research, development and demonstration
- breeder reactor fuel fabrication
- breeder fuel reprocessing and fuel recycle
- waste disposal

In conclusion, the Administration's concern about proliferation of nuclear weapons is shared by most people and the domestic utilities suppport reasonable programs to improve the safeguarding of nuclear materials and sensitive technologies. However, the world must take advantage of the nuclear power option for both near term electricity production and as a long term energy resource.

While thermal reactors can serve the near term need, fast breeder reactors with adequate breeding gains are essential to serve the long term need of this nation and the world. The nation must proceed with an active RD&D program to utilize this energy resource.

To achieve the best practical safeguards for each of the sensitive technologies, the U.S. must perform RD&D programs in each area and prepare for their eventual use within the world community. Technical fixes must be sought and developed to minimize the potential for theft of nuclear materials but the primary control of proliferation is through cooperative programs and appropriate international institutional arrangements.

[illegible]

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
[illegible]
WASHINGTON, D.C. 20515

[illegible]

June 11, 1980

Mr. Jack Kearney
Senior Vice President for
  Energy and Environmental
  Activities
Edison Electric Institute
1111 19th Street, N.W.
Washington, D. C. 20036

Dear Mr. Kearney:

Thank you once again for appearing before the Subcommittee on Energy Research and Production during our June 5 hearing on the International Nuclear Fuel Cycle Evaluation study, and the implications for future nuclear energy research and development. We found your testimony particularly insightful and useful, and we sincerely appreciate you sharing your expertise with us.

During the hearing, we indicated that the Subcommittee might request some additional information in the form of further questions. Having reviewed the testimony received at the hearing, we find that additional information would be very helpful. Accordingly, we would appreciate your providing, for the record, responses to the enclosed questions.

Your prompt reply would be most appreciated. Thank you for your cooperation on this matter.

Sincerely,

Mike McCormack

MIKE McCORMACK, Chairman
Subcommittee on Energy
Research and Production

MM/Cwm

Enclosure

QUESTIONS FOR
Mr. Jack Kearney
following
INFCE HEARINGS
June 5, 1980

1. How is the domestic U.S. nuclear power industry affected by our international policies, such as the indefinite deferral of commercial reporcessing and plutonium recycle? Is plutonium recycle in LWR's regarded as economic by the utilities, and if not, how can we rationalize proceeding with it in view of our desire to avoid widespread distribution of plutonium abroad? What role should economics play in decisions on reprocessing?

2. What effect do our recent agreements with Australia and Canada have on domestic U.S. utilities? Do utilities which purchase uranium abroad see any problem in adding the approval of foreign governments to that of the U.S. government for reprocessing the material they have bought?

3. Much of the U.S. criticism of INFCE has been directed toward its conclusion that uranium supplies might be adequate only to as early as 2000 or, at the latest, 2025 and the implications of this analysis for the time at which commercial fast-breeder reactors would first need to be deployed. In this regard:

   a. What is the validity of a "global" analysis of actual and prospective uranium reserves of this type? It fails to recognize the significant impacts of (1) market factors and economics, (2) rate at which uranium discoveries can be exploited and (3) perhaps most important, political considerations which may make much of the geologically available uranium practically unavailable, at least to some nations.

   b. Even if uranium reserves were to prove to be adequate for light-water reactors on a once-through cycle until, say, 2025, how long do you believe that utilities would continue to purchase such reactors in the absence of a viable nuclear alternative, such as the fast breeder, beyond the time the "last available pound" of U_3O_8 has been identified? Is such a situation conducive to a dynamic U.S. nuclear industry, prepared to invest its funds in continuing research and development?

   c. In making the INFCE forecasts for future electrical generating capacity requirements - which (at least in a rational world) would correlate with estimates of future nuclear power growth -couldn't the need to replace between now and 2025 obsolete generating capacity built immediately after World War II have substantially increased the estimates of nuclear power growth?

4. What is your assessment of the practicality of improving the uranium efficiency of light water reactors? Would the saving be worth the effort in R&D, and in capital investment by the utilities? If not, would public investment be warranted for uneconomic changes simply to reduce U.S. uranium demand and free up world uranium supplies?

5. If nuclear power plants are supplied to smaller countries, how can we prevent their operation by unqualified personnel, or with inadequate technical back-up? Would the supplier states be risking a series of Three Mile Island accidents or worse? Would it make any sense to try to establish either a commercial or an international organization to operate nuclear power plants of smaller countries?

JOHN J. KEARNEY Senior Vice President

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July 1, 1980

The Honorable Mike McCormack, Chairman
Subcommittee on Energy Research and Production
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D. C. 20515

Dear Mr. Chairman:

I appreciated the opportunity to appear before your Subcommittee on June 5, to present views on the International Nuclear Fuel Cycle Evaluation Study and its implications for future nuclear energy research and development. The following comments are provided in response to the questions related to the Hearing that you asked in your letter of June 11, 1980.

Response to Question 1:

The international policies of the U.S. Administration on nuclear power are counter in many ways to the results of the International Nuclear Fuel Cycle Evaluation (INFCE) study. This international posture of the Administration adds confusion to the domestic nuclear power industry because it differs from the logical paths being pursued by friendly developed foreign nations. Such confusion has an adverse impact on domestic nuclear power and adds more uncertainty to the overall nuclear programs. While the U.S. Administration has participated in and agreed to an international economic summit statement that calls for increasing the use of nuclear power, it continues to discourage foreign countries on reprocessing and plutonium recycle which are important elements of increasing nuclear power. These conflicting directions contribute to greater uncertainty for nuclear programs.

The rationale for urging the U.S. to proceed with the development of reprocessing and plutonium recycle is twofold; 1) uranium is a limited resource and the option for extending its usefulness must be developed in a safe manner, and 2) the very best safeguarding approaches must be established for the world community and this can only be achieved by actively participating in their development rather than allowing foreign countries to proceed with reprocessing and plutonium recycle without U.S. participation in developing the necessary safeguards.

Economics will play the predominate role in commercial reprocessing and domestic utilities will not contract for reprocessing services unless they are economical or necessary to achieve effective waste management. However, the reprocessing option must be sufficiently developed with effective safeguards to permit a determination on the economic assessment.

Response to Question 2:

The principal concern of the domestic utilities with the recent Agreements with Australia and Canada relate to those provisions which affect the import and use of foreign uranium as a fuel for nuclear power generation by domestic utilities. The unqualified right of foreign governments to approve any reprocessing of domestic spent fuel that contains uranium purchased from suppliers in a foreign nation adds another uncertainty to when or whether reprocessing of this material can be performed. Thus, even though the U.S. Government policy may eventually permit domestic utilities to reprocess their spent fuel in the future, prior approval would still have to be obtained from a foreign government if foreign uranium is used. Such an arrangement is unreasonable and may abridge the property rights of domestic utilities. Additionally, the Agreements do not provide a mechanism for obtaining any approvals that may be required by the Agreements.

Response to Question 3:

Every attempt, including that of INFCE, to judge the timing for commercial deployment of fast-breeder reactors, as a directly related consequence of the quantity of uranium resources, has missed the basic question of long-term logistics that guide the decisions for ordering a power plant. Such decisions must be made on a 40 to 50 year future time scale that considers the estimated economic availability of fuel over the full life of the plant. Thus, any study suggesting that the uranium resource is adequate only to the year 2025, implies that LWR nuclear power plants should not be ordered after 1975, since it takes at least 10 years to build a plant and the plant is expected to run for 40 years, until 2025.

Any "global" analysis of uranium reserves will assist in defining the economics of uranium but will have little effect on the time for deployment of commercial breeder reactors unless very substantial, exploitable, new resources are discovered. While there are many important factors about the availability of uranium, the controlling factor is that uranium is a limited resource that can be relied on as fuel for only a few decades with a once-through fuel cycle.

The current estimates on uranium reserves within the U.S. suggests that life-time fuel requirements for about 400 GWe of LWR nuclear plants should be available. Thus, it appears that additional nuclear power plants can be ordered up to a total of about 400 GWe. This limited potential growth is not conducive to dynamic research and development on LWR by the nuclear supply industry. Major research and development is attractive for breeder reactors which are not fuel resource limited.

Since a generating plant is expected to operate for 30 to 40 years, nearly all plants constructed prior to 1985 will be obsolete by 2025 and should be replaced. Approximately 700 GWe of domestic electricity generating capacity will be operable in 1985. Essentially, all of it will need to be replaced between 1985 and 2025. Only coal and nuclear power are recognized as available options for replacing the steam generation portion of this capacity and for building new base-load capacity. A reasonable balance of both should be deployed along with the rebuilding of all available hydro generating capacity.

Response to Question 4:

All economical improvements in uranium efficiency with light water reactors should be vigorously pursued. A 15 percent efficiency improvement, as indicated in INFCE, appears to be achieveable and the R&D and capital investment for this appears to be reasonable and warranted. Improvements beyond that are in doubt and should be pursued with caution. A public investment is not warranted for uneconomic changes since they would have only a minimal effect on the period of time that uranium resources would be available.

Response to Question 5:

Each utility and each country must accept the responsibility to operate their nuclear power plants safely. This requires fully trained and qualified operators and the appropriate technical backup. Neither equipment suppliers or other nations can force a small nation to provide the proper people resources except by persuasion. It does not appear practical to establish a commercial or international organization to operate nuclear power plants of smaller countries but it does appear reasonable to have international teams of experts perform period evaluations to assure that the technical and personnel resources and procedures are appropriate for operating nuclear plants.

These comments respond to your specific questions. I will be pleased to discuss these items in greater detail at your convenience.

Sincerely yours,

John J. Kearney

jam

Mr. **Wydler**. I thank you. I have to say I was at the White House about a week ago and the new Secretary of State was mentioning the fact that the European countries had not come through with the full economic sanctions that we had asked them to come through with against Iran and he said we had the problem of trying to decide whether to declare it a victory or a defeat. We got half of what we wanted, so we didn't know whether we should claim victory or just admit defeat.

I think to some extent we have that same situation with the INFCE report. The administration doesn't know whether it should claim victory or defeat, but I don't think they in any sense of the word got the kind of report they were hoping they were going to get when they decided to have the conference. But be that as it may, the thing that gets me about the international situation is in my travels around the world and discussions in foreign countries it leads me to see the situation a lot differently from the Members of Congress or many of them who sit here and apparently have a preconceived notion of what our position is in the world. A lot of Members of Congress seem to be of the opinion that if the United States decides somebody cannot have some nuclear technology or nuclear material they don't get it. It is such a naive conception. It might have been true 20 years ago, but it is so out of date and so unrealistic, the only thing we do is when we go to these foreign countries and say we won't give you the nuclear material, they say well, gee, that's too bad, we'll buy it somewhere else. And, of course, they go ahead and do it.

So it's not like we're denying anybody anything. It is just saying we won't sell it to you and you'll have to buy it elsewhere, which in every case they are willing to do. But a lot of people here seem to be of the opinion that the United States can say you're not going to get it from us and they don't have it.

There are some Members of Congress that labor under that delusion that we somehow control this whole situation and can call the shots and we have some kind of monopoly. It just isn't so. The only thing we have left which, of course, is fast disappearing, is the old contractual relationships we have developed with many of these countries where we were their supplier of uranium and they depended on us and they still do.

We've got them in that position at this moment. But, of course, that isn't going to last very long, because we are trying to play games with them on their supply and they are obviously going to find other supplies that are reliable and we'll be out. I don't know how long we can think that is going to go on. Again, it is a game that is self-defeating. You can see it happening and yet we continually go ahead on this assumption that if we won't give them uranium they can't get uranium. We can squeeze them for a short period of time but all you do is enrage them and force them to go some place else, maybe to the Soviet Union. They will be glad to sell them the uranium.

I don't know what we think we're accomplishing. It is a mystery but you come back here and people actually think the United States can call the shots. It just isn't so. Anyway it seems like an idea that really hasn't gotten through to a great many people that we are not in the same world that we were 20 years ago with nuclear energy.

We are not bestowing it on the rest of the world as we did at the time President Eisenhower decided the Atoms for Peace program would go forward. We were really bestowing our technology on the rest of the world. We were very gracious and we were in control of the situation. But those days are long gone, and if we don't start living in the world that exists, as you say, we will not only be out but we will be shunned by the rest of the world. They will not only not invite us in but they will keep us out. I can see that developing very clearly, because a lot of these countries are enraged at the American attitude on nuclear power.

I have no other questions for you, but I wonder if we shouldn't wait in deference to the chairman for his return because I'm sure he will have some questions. He should be back momentarily.

[Discussion off the record.]

Mr. **Kearney**. If I might, Mr. Wydler, there was one other thing which you reminded me of as we started talking. As good citizens the U.S. utility industry was appreciative of the INFCE study, not that we really had anything to do with it one way or the other. But it put us in a holding pattern for 2 years. We really couldn't do anything, and now those 2 years are over and we hope that the U.S. Government with the help and urging of the Congress will get on to do something.

Mr. **Wydler**. It's a point I made yesterday. We had some of the administration people here and I said you called for this worldwide study basically to have the world adopt our position. It didn't work that way, but then you came before the committee for the last 2 years and you argued every time we were trying to continue with our program. Well, don't make these decisions now. Wait for the INFCE study. As soon as that comes out we'll have the direction on which way we will go. So they tried to hold us up from doing anything and now that it is out, and it isn't what they want they argue that it doesn't mean anything. It is not important, but it is just a statement of a lot of people's opinions. That is what they are doing, just running around in circles and trying to kid us along. But I don't think they are fooling the committee or the Congress, frankly. We are wise to it, but unfortunately there are just not enough Congressmen yet to be able to do to the President on nuclear power what we are going to do to him on the gas tax.

But that day may come or some other things may change, including the President. So there are hopes at least for the future. I don't think he's going to change his mind. I'm not counting on that happening.

Again, I don't want to——

Mr. **Kearney**. I'd be glad to stay, Mr. Wydler.

Mr. **Wydler**. If you would, and then if the chairman has any questions he would like to ask you, you will be here to answer them.

Mr. **Wydler**. Then we will proceed.

Our next witness is L. Manning Muntzing who is the coordinator for the American Nuclear Society on INFCE matters and a member of Doub & Muntzing, chartered. Mr. Muntzing, we are looking forward to hearing your testimony and you may proceed at this time.

Is that chartered like incorporated?

Mr. **Muntzing**. Mr. Wydler, that's exactly correct.

Mr. **Wydler**. At this point without objection, I would like to put into the record of these hearings an article called, The Use of Plutonium which is the text of a lecture by Dr. Walter Marshall who is the deputy chairman of UKAEA on the nuclear power proliferation issue.

I know Dr. Marshall to be one of the most informed and energized fighters in the nuclear field, and I think this will be of great help to the committee and the members of Congress.

Mr. Chairman, without objection, I would like to place that in the record.

Mr. McCormack. Without objection, it is so ordered.

THE USE OF PLUTONIUM

Two years ago ATOM published the text of a lecture by Dr Walter Marshall, deputy chairman of the UKAEA, on 'nuclear power and the proliferation issue'.* In it, Dr Marshall discussed the proposition that the growth of nuclear power throughout the world carried with it the possibility of proliferating nuclear weapons capability, analysed which problems in his view were real and which were a misapprehension, and tried to suggest a way forward which retained the benefits of nuclear power while giving more certain protection against proliferation.

At the end of February — immediately after the conclusion of the International Nuclear Fuel Cycle Evaluation — Dr Marshall returned in a lecture at the Royal Institution to one aspect of his earlier theme: how plutonium could be used as a vital energy source producing the maximum economic benefit with minimum proliferation risk. The following paper, developed by Dr Marshall from an unpublished lecture given at Salford University on 29 October 1979, goes into the subject in greater detail.

The nuclear age was announced with the explosion of the two weapons which brought an end to World War II. Naturally, therefore, the possibility of nuclear weapons proliferation being associated with civil nuclear power has been recognised from the very earliest days. This awareness led, at an early date, to the setting up of the International Atomic Energy Agency (IAEA) in 1956, the Treaty of Tlatelolco in South America in 1967 and the Non-Proliferation Treaty in 1968.

More recently, the International Nuclear Fuel Cycle Evaluation exercise (INFCE) was launched on President Carter's initiative in 1977. In his statement at that time, the President pointed out that the use of nuclear power worldwide was growing and that many countries were making plans for the use of plutonium in their civil nuclear power programmes. The President asked for a period of reflection and study before the "plutonium economy" became an established fact and, to demonstrate his concern on this matter, he postponed indefinitely the United States' plans to reprocess spent fuel, (to obtain separated plutonium from spent fuel elements), postponed indefinitely the use of plutonium in thermal reactors, and deferred commercialisation of fast breeder reactors. The setting up of INFCE with the wholehearted collaboration of Governments throughout the world is, in my opinion, evidence of a renewed political will on an international scale to avoid, if at all possible, the further proliferation of nuclear weapons. I believe that scientists like myself have a responsibility to respond constructively to such political initiatives and this lecture should be looked at in that light.

My training as a scientist compels me first to describe the assumptions upon which I will base the remainder of the lecture. I shall assume that nuclear power is needed on a growing scale to satisfy the energy requirements and legitimate aspirations of human beings throughout the world. I am satisfied that nuclear power plants can be operated safely and without harm to the environment. Nuclear power is the most economic method of producing base load electricity in the United Kingdom, and this appears to be true in most, if not all, other advanced countries. I judge that it is likely to become the most economic method in other countries too on a timescale measured in decades. All these points could and should be debated but I cannot give time to them today. Even if I confine my attention only to the question of nuclear proliferation then a general discussion is so complex that it would not be possible to be comprehensive in the space of one lecture. I shall, therefore, not discuss the possibility of using enrichment techniques to make the material for a uranium-235 weapon, nor shall I discuss the use of thorium to make a uranium-233 weapon. But I shall again record my view, as I do in every lecture I give on proliferation, that the potential dangers from these two possibilities are as great as, or greater than, the equivalent dangers from the use of plutonium. Nevertheless, the current non-proliferation debate has concentrated heavily in the recent past on the need to control and limit the availability of plutonium and, since that is an important issue, I shall concentrate exclusively upon it.

Throughout, it is important to remember that a determined Government anywhere in the world could equip itself with nuclear weapons whether it has civil nuclear power stations or not and whether it has plutonium or not. Therefore, the question of nuclear proliferation is primarily a matter of international politics and we must guard against the risk of advocating technical solutions to political problems. There are, indeed, no technical solutions to a political problem but there may be technologies which can assist a worldwide non-proliferation regime and it is our responsibility as scientists to analyse, advocate and develop those technologies which best assist a broad political intent, and the consequent institutional arrangements such as the existing IAEA Safeguards programme and other institutional arrangements now under international discussion.

I shall not, therefore, produce a "solution" to proliferation; only governments can do that. I shall simply try to point the way to the best policy and the best institutional arrangements which would be helpful for non-proliferation. For this reason I shall make the further assumption that any lasting non-proliferation regime must be based upon the voluntary support of all — or the vast majority — of States in the world. In my opinion, a policy based upon permanent denial of materials, facilities or technologies is bound to fail. It is not possible to have a policy which confines the use of plutonium, the operation of reprocessing plants, the operation of fast reactors etc. only to the weapons states and a selected number of non-weapons states. Such a policy which denied those facilities or technologies to other nations would be resented and be self-defeating. However, on the other hand, if there is to be a voluntary regime it must be one which works to the economic advantage of all States and, at first sight, that seems to be an impossibility. If it is of economic advantage for one country to use plutonium, surely it must be to the economic advantage of all countries to use plutonium. Later on in this lecture, I shall explain how that is not true. I shall explain how, if some countries develop their use of plutonium in an economic way, then other countries can benefit similarly but without following their example, and I shall show how a situation could develop, in which, without putting aside economic self-interest, some countries might decide to make use of plutonium while other countries might equally, and voluntarily, decide to avoid the use of plutonium. Such a regime, if it were established, would not guarantee the non-proliferation of nuclear weapons because the countries handling

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Dr Marshall addressing his audience at the Royal Institution

the plutonium may or may not have a rigorous commitment to non-proliferation. However, it does give the maximum possible opportunity to governments, through diplomatic action, through mature and prudent decisions, and through the interdependence of countries one upon the other, to secure the most proliferation-resistant regime possible.

Input	0	for PWR
Creation	+710 kg	
Destruction	−440 kg	
Net production	+270 kg	
	+617 kg	for Magnox
	+493 kg	for Candu
	+173 kg	for AGR

Figure 1 The production of plutonium expressed as weight of plutonium-239 for each GWy of electricity

Production of plutonium

We must begin the technical discussion by examining the facts about the production and availability of plutonium. I do not apologise for doing this in an extremely elementary fashion because these basic facts are frequently misrepresented in the literature.

The basic fission process for uranium-235 is well known. A neutron colliding with a U-235 nucleus causes it to split into a pair of "fission product" nuclei, in the process releasing heat energy and two or three further neutrons. These neutrons in turn collide with more U-235 to produce more fission products, more energy and more neutrons, thereby setting up a chain reaction, which can be harnessed to produce heat and electricity. The operation of present-day thermal reactors depends upon this process. However, U-235 forms only a small fraction of uranium as found in nature. The major part of natural uranium is uranium-238 and this isotope, when irradiated within a reactor, also enters into an important nuclear reaction, absorbing a neutron to give uranium-239 which decays to give plutonium-239. Since a thermal reactor must inevitably contain both U-235 and U-238, it follows, therefore that the production of plutonium is an inevitable and necessary consequence of producing electricity by nuclear power.

Plutonium itself can be used as a nuclear fuel, since it functions as a fissile material in a manner very similar to U-235. Indeed as soon as plutonium is produced in a thermal reactor, it immediately starts to incinerate itself. However, since it must be produced before it can be incinerated, the former must exceed the latter and hence, in a thermal reactor, the production of plutonium from U-238 must exceed the partial incineration in situ of that plutonium. This dynamic situation where plutonium is both produced and incinerated simultaneously can be illustrated by an analogy to running water into a bath with the waste pipe left partially open. As water enters the bath (as plutonium is produced), some of it also runs out of the bath (plutonium is also incinerated) but, if at any one time we abruptly stop the experiment (withdraw the fuel elements), we will have water in the bath (we will have plutonium in the fuel elements).

A typical balance sheet for a thermal reactor is shown in Figure 1 where I have chosen to use the PWR as an example of a thermal reactor because that is the reactor used most commonly throughout the world. I have standardised all the numbers in this Figure and in subsequent similar Figures to the amount of plutonium produced in equivalent kilograms (Ekg)† from the operation of a 1 000 MWe reactor for 365 days. The left-hand side of the Figure shows that this size of reactor, operating for a full year, creates 710 equivalent kilograms of plutonium by the irradiation of U-238. Simultaneously, and partly compensating for that creation, the plutonium is incinerated in situ by fission to an amount of 440 Ekgs, giving a net creation of 270 Ekgs. Clearly we need not concern ourselves at all with that plutonium which is created and destroyed in situ. We need, therefore, only remember that the amount of plutonium put into the reactor is zero and that the amount which is taken out is 270 Ekgs. We conclude, therefore, that a thermal reactor of this type and size produces 270 Ekgs of plutonium each and every complete year it operates. For comparison, Figure 1 shows the plutonium production in our own Magnox power stations, and in the Canadian CANDU stations. We see that the figures are larger — roughly 617 Ekgs and 493 Ekgs respectively — when expressed in equivalent units. The Advanced Gas-cooled Reactor, due to its high thermal efficiency and to other factors, has a significantly lower net plutonium production, 173 Ekgs annually.

Since the production of plutonium in any reactor is inevitable, we must now consider what to do with it. It is contained in the fuel element which must be removed from the reactor when the fission of the uranium-235 contained in it has proceeded far enough. This fuel element is then highly radioactive because of the fission products it contains in addition to the unburnt uranium and the newly created plutonium. The plutonium itself makes a negligible contribution to the radioactivity. However, the radioactivity emitted by the fission products is both intense and dangerous and, therefore, the fuel

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† See Appendix 1 for a fuller explanation of this unit

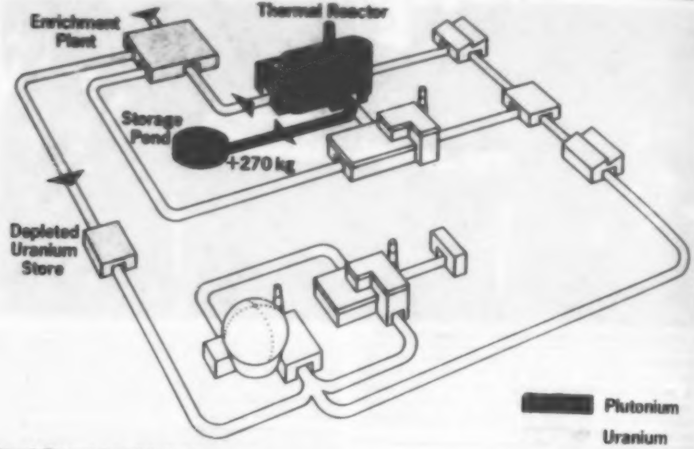


Figure 2 The once-through fuel cycle

element must be handled remotely and cannot safely be approached by human beings without heavy shielding.

The first choice we have is to leave the plutonium where it is — inside the fuel element. At first sight, this has obvious attractions from a non-proliferation point of view because the high radioactivity of the fuel element acts as an "automatic policeman" to guard the plutonium it contains. If we leave the plutonium in the fuel element and simply put that fuel element in a storage pond, then we have what is known as the once-through fuel cycle as illustrated in Figure 2. The most convenient storage pond is the one at the reactor itself and therefore in practice the "once-through fuel cycle" simply retains the spent fuel elements at each of the many thermal reactors where they are created.

This fuel "cycle" has a number of advocates, especially in the United States, and it is the fuel cycle which, for the time being, is operated in that country. The alternative to storing the fuel element is to send it to a reprocessing plant which separates out the fission products as a waste material, and the uranium and plutonium as separate products which can then be used in various ways indicated in Figure 5, 6 and 8, which we will discuss later in this lecture. However, let us first pause to examine the merits, or otherwise, of the once-through fuel cycle shown in Figure 2.

We see immediately that it has one dramatic disadvantage: it treats both the unburnt uranium and the plutonium which is contained within the fuel element as waste products. They are both potentially valuable fuels and this is not a good policy on energy conservation grounds. However, it is important for us to examine this cycle from the point of view of non-proliferation. Clearly we would not wish plutonium to be scattered around the world as a waste product in every reactor cooling pond if it were not protected by the intense radiation field of spent fuel elements. However, there is a serious limitation to the degree of protection which that radioactivity can give and this follows from the fundamental laws of physics. A material is highly radioactive if the atoms it contains are decaying rapidly. If they are decaying rapidly they cannot exist for a long time. In short, you can have high radioactivity for a short time or low radioactivity for a long time but you cannot have high radioactivity for a long time. The radiation field from a PWR spent fuel element in air therefore falls off with time following the curve shown in Figure 3.

In the early years, this radiation field gives such protection to the plutonium that only the most experienced and mature fuel companies or the most elaborate government effort could reprocess the fuel element and extract the plutonium from it. However, as time goes on, Figure 3 shows that ceases to be true. Furthermore, the radiation field from spent fuel in water is some orders of magnitude lower than shown in Figure 3, and if fuel is handled under water, this brings forward the time at which the plutonium could be accessible to a government or large sub-national group. For my purpose, it does not matter whether we judge that time comes after 10, 20 or 50 years. What is clear is that there is a risk that the once-through cycle will lead to numerous, widely dispersed stores of spent fuel throughout the world and that the plutonium in that spent fuel becomes steadily more accessible as the radioactivity of the fission products decays. As a result continued use of the once-through cycle would entail a need for careful safeguarding and a high level of physical protection, and

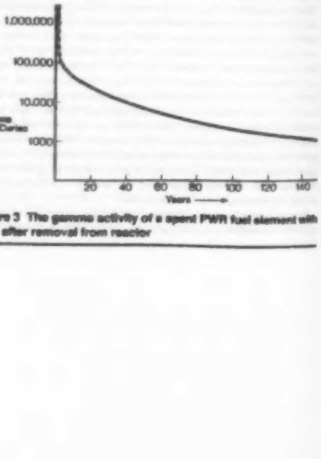


Figure 3 The gamma activity of a spent PWR fuel element with time after removal from reactor

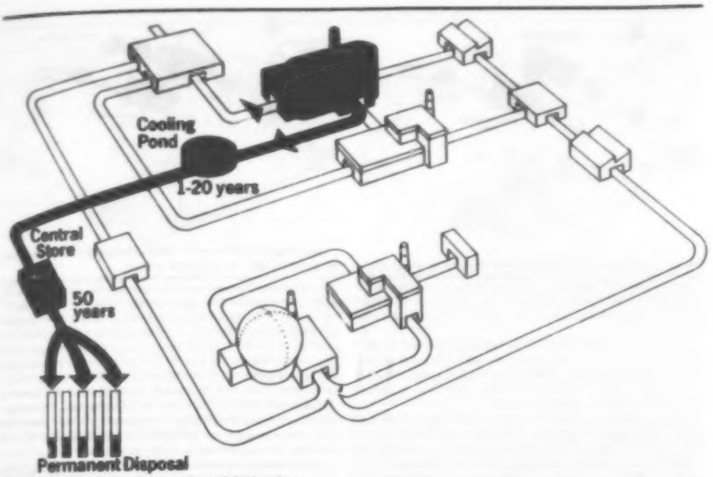


Figure 4 A variation on the once-through fuel cycle

careful thought would need to be given to how this should best be assured. I do not want to suggest that it cannot be done. What is clear however is that the problems involved are significant and probably require new institutional arrangements such as IAEA, International, or Regional Spent Fuel Storage Schemes, which all suffer from a lack of positive motivation at the national level, because no economic nor energy resource purpose is served by indefinite spent fuel storage. Therefore in considering the form an acceptable long-term non-proliferation policy should take, there are major advantages to the alternative of retrieving the fuel in one way or another for a useful purpose.

The once-through fuel cycle was first advocated as a non-proliferation policy in the Ford-Mitre book entitled *Nuclear Power Issues and Choices*. The authors' argument rested upon a number of points taken together. They were nervous of the use of separated plutonium throughout the world and they therefore wished to postpone reprocessing for as long as possible. They were so convinced that spent fuel elements could be dealt with safely that they suggested they should be retrieved from the other countries and stored, possibly in the United States, perhaps preferably in a multinational store. It is not clear how much the Ford-Mitre proposals were dependent upon the intrinsic difficulty of reprocessing spent fuel and how much they were dependent upon retrieval of spent fuel. However, for the reasons outlined earlier in this lecture, the technical difficulties of reprocessing spent fuel decrease decade by decade and, therefore, it surely must be unwise to rely upon that technical factor indefinitely. The universal retrieval of spent fuel into the United States would be distasteful to the American public and would be perceived as discriminatory against Non-Nuclear Weapons States. Indeed more recent statements from the US Administration have suggested that the storage of foreign spent fuel in the United States could be done only to a limited degree.

For these reasons, the Ford-Mitre proposals, if they involved retrieval into the United States would, in my opinion, be inoperable. It may be practicable, and it certainly would be desirable, to retrieve spent fuel into a small number of international stores but the institutional difficulties facing proposals to do this for the indefinite future are formidable. I accept that the once-through fuel cycle has an important role to play for an interim period but stress that we must find a way to move from that to a more constructive regime.

There is one further variation of the once-through cycle we need to consider, which is that the spent fuel elements should be buried in some geological repository at a relatively early date. This, in my view, is not an acceptable proposal. The effect of such a policy would be to remove valuable materials from the practical possibility of being used and as a result severely to limit the economic value of the world's uranium reserves. The option is in any case one which for technical reasons is not immediately available to us, the properties of spent fuel elements being different from those of vitrified highly active reprocessing wastes, and less well understood. Many more years of geological research will be required before everyone is agreed on the proper place for a geological repository. It will furthermore be necessary to "cool" the spent elements for several decades before any repository can be sealed. It seems inevitable, therefore, that this proposal would simply result in the plutonium within the spent fuel elements being stored either on the surface or underground in what is effectively a "plutonium mine". This is shown in Figure 4 and combines all possible disadvantages: the retrieval of plutonium for civil use is made economically difficult but the retrieval for a weapon (where economics does not matter) is retained as a constant temptation. This proposal for early burial is thus an artificial and impracticable one. Arguments in favour of it, so strident two years ago, are now conspicuous by their absence.

Other fuel cycles

If we conclude that it is not plausible to store spent fuel elements indefinitely or bury them irretrievably in the foreseeable future, what then is to be done? The only alternative is to send them to the reprocessing plant, perhaps after storage for a few years, so that the fission products, uranium and plutonium can be seperated. It is not my task today to discuss the fate of fission product waste and I shall, therefore, simply note that, in my view, the storage and disposal of these materials do not present major problems which need limit nuclear power development. In this lecture I intend to concentrate

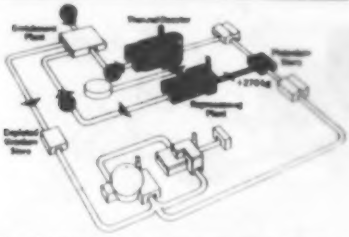
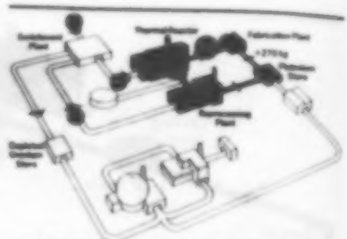


Figure 5 The reprocessing cycle described by Dr Marshall . . .



. . . and (Figure 6) the way in which uranium and plutonium may be recycled, back to a thermal reactor

on what can be done with the uranium and the separated plutonium. Clearly what is done with the plutonium now it has been separated from the fission product activity is vital for any non-proliferation considerations.

The uranium separated out in the reprocessing plant can be recycled back to the enrichment plant to make new thermal reactor fuel and, if the uranium alone is recycled and the plutonium is placed in a plutonium store, then we have what I shall refer to as the "reprocessing cycle". Figure 5 shows this.

Another possibility, shown in Figure 6, is to recycle both the uranium and plutonium back to the thermal reactor. I shall refer to this as "thermal recycle". Both these fuel cycles economise on the supply of uranium fuel needed to operate the thermal reactor.

Figure 7 shows the uranium requirements for a thermal reactor using the once-through, reprocessing and thermal recycle fuel cycles. The figure shows that the recycle of uranium alone economises on the supply of uranium fuel by 23 per cent and the recycle of plutonium saves up to an additional 16 per cent giving an economy of up to 39 per cent overall. If, therefore, the supply of uranium becomes scarce and the cost of uranium ore consequently gets high, then both fuel cycles have value from an economic point of view. However, in contrast to the fast reactor option we shall discuss later, the savings in uranium requirements are not dramatic. Both fuel cycles for thermal reactors may be seen as helping stretch out somewhat the energy we can get from a given amount of uranium. This marginal advantage should be balanced against any disadvantages they might have.

It is worth examining thermal recycle in more depth. Let us suppose a few countries reprocess their spent fuel and set up the facilities to refabricate plutonium into thermal fuel elements to be returned to the thermal reactors. Such reprocessing does not of itself constitute an incremental proliferation risk if carried out inside any country at an advanced industrial stage: any such country that wanted to equip itself with nuclear weapons could, as I have said, do so anyway, and the use of thermal recycle will not of itself act as an important determining feature. However, if the price of uranium ore continues to go up, then other countries will also see this as a desirable step forward and they will then first ask for their spent fuel to be reprocessed and the plutonium refabricated (both steps to be done as a service to them). Then, subsequently, they will undertake the fuel fabrication step themselves and perhaps eventually even undertake reprocessing themselves. This is the natural evolution to follow. There is no design difference between the thermal reactor which is operating on plutonium and one which is operating on uranium. The normal evolution of thermal recycle would, therefore, result in separated plutonium being handled in many countries throughout the world — possibly without full-scope safeguards — and it is this concern which, in my opinion, stimulated President Carter to ask for a study of the whole question of fuel cycles.

The opposition expressed by the United States Administration to thermal recycle is one which many countries have shared. There is, as we have seen, a risk that if plutonium-bearing thermal reactor fuel is developed and used in any thermal reactors, it will ultimately be used the world over. This may give rise to a significant increase in the technical opportunities for proliferation with only a marginal economic and resource gain to set against that risk. The plutonium used in thermal reactors would accumulate an increasing proportion of the Pu 240 and Pu 242 isotopes, and as a result its value as a thermal reactor fuel would diminish fairly rapidly. Hence the relatively low level of uranium savings which this mode of plutonium utilisation can achieve. At the same time this isotopic mixture, which would have a higher fissile worth in a fast neutron flux, could still, in principle, be put to use in a nuclear weapon. I do not advocate the total avoidance of thermal recycle and cannot do so while maintaining that each nation must be free to act in its own self interest. However there is force to the argument that the use of plutonium should be reserved for applications where it produces large benefits. The avoidance of thermal recycle is not inconsistent with attitudes as they have existed in the United Kingdom for many years because, in this country, we have always felt that the most natural step to take with plutonium is to use it in fast reactors and that, therefore, the use of plutonium in thermal reactors, in what I am here calling the "thermal recycle mode", would be an inappropriate use of a valuable fuel.

The arguments given so far suggest that plutonium should not be left indefinitely in spent fuel elements and that there are doubts as to the value of recycling it to thermal reactors. There is, however, another alternative left: to use the plutonium to launch fast reactors. This has been the intention in the UK, in France and in a number of other countries of the world from the very earliest days of the nuclear power programme. Indeed, it is noteworthy that the very first reactor to operate and produce electrical power was a fast reactor built in the USA (EBR 1). Furthermore, the first reference to fast reactors in the archives of Harwell occurs in 1948, long before AGRs and SGHWRs were even contemplated! At first sight, there seems to be no difference in principle between using plutonium for thermal reactors and using it for fast reactors, and it is presumably for this reason that the phrase "plutonium economy" is used to cover both without making a distinction between them. The references I have seen to the "plutonium economy" do not bring out any significant difference

FUEL CYCLE	Once-through	Reprocessing	Thermal Recycle
URANIUM REQUIREMENTS TONNE/GW(e) yr	212	163	129
% REDUCTION OVER ONCE-THROUGH	0	23%	39%

Figure 7 Uranium requirements for a thermal reactor using the once-through, reprocessing and thermal recycle fuel routes

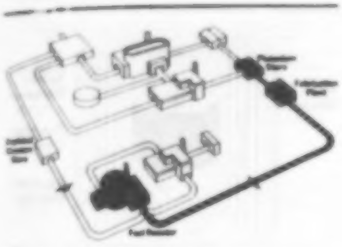
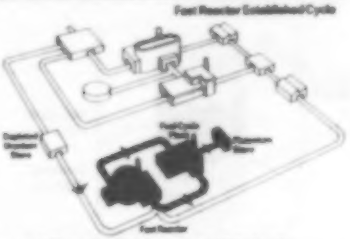


Figure 8 The fast reactor launch cycle . . .



. . . and (Figure 9) the fast reactor established cycle

between these two ways of using plutonium. The risks of using plutonium in thermal reactors are assumed to apply to the use of plutonium in fast reactors without further examination. In my judgement this is a mistake because the use of plutonium in fast reactors gives us an opportunity for a non-proliferation policy which is simply not available when we consider only the use of plutonium in thermal reactors. My main purpose in this lecture is to explain how this comes about. Obviously I cannot do that without first reviewing the basic operational factors concerning fast reactors and this, therefore, is the next matter for us to examine.

The fast reactor

In order to start up a fast reactor, unless we are to adopt the course of using U-235 for the initial core enrichment, we must first obtain a stock of plutonium from the operation of thermal reactors. When sufficient plutonium has been accumulated, we can launch the fast reactor as shown in Figure 8. Once launched, the fast reactor is self-sufficient and actually may make some excess plutonium year by year. We then get the fuel cycle shown in Figure 9 which is required to maintain the fast reactor in operation. In this way we can have a fuel cycle which is effectively self-sustaining. In understanding how this works, a simple analogy may help. Imagine a group of castaways on a beach, trying to keep warm. We suppose they have a small supply of dry wood, together with a large supply of wet driftwood, washed up on the shore. What are the ways in which they could use their supply of fuel? They could simply use the dry wood to build a fire, which would keep them warm while the dry wood lasted. After that, when all of the dry wood was used up, they would get cold.

However there is another and more intelligent way in which these castaways could make use of the wood at their disposal. In addition to making a fire with the dry wood, they could build a blanket of wet wood around the fire. Then as the dry wood was burnt up, as well as keeping them warm, it would also dry out some of the wet wood, to give a fresh supply of dry wood. In this way, the castaways could keep warm in perpetuity.

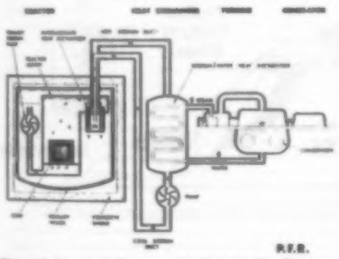
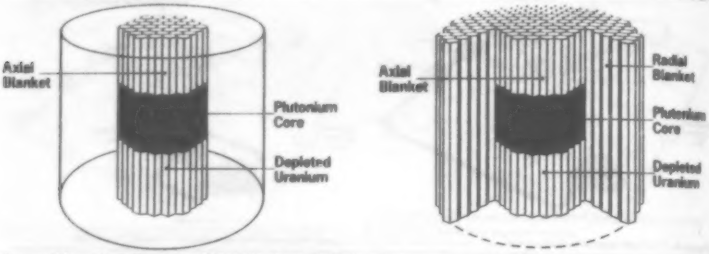


Figure 10 The circuit diagram of the Prototype Fast Reactor

We have here a simple but precise analogy to the operation of the fast reactor. The fire of dry wood is analogous to the incineration of plutonium in the core. The drying out of the wet wood originally put in the blanket is analogous to the production of plutonium from the uranium-238 blanket. The wet wood is analogous to uranium-238, both useless waste products unless used in this way. The operation of building up the blanket with wet wood, extracting dry wood from it and throwing dry wood on to the fire are exactly analogous to the fast reactor fuel cycle.

Figure 10 shows the circuit diagram of a fast reactor. The fission process takes place in the core and produces heat which is carried away by liquid sodium. That liquid sodium is confined within a large pool and exchanges its heat with a second (so-called intermediate) circuit of liquid sodium. This intermediate circuit transfers the heat within the sodium pool to steam generators where the heat is transferred from the intermediate circuit to water, thus making steam to drive the turbine. Apart from the use of liquid sodium and the presence of the intermediate sodium circuit, this operation is entirely similar, in broad principle, to the operation of a thermal reactor. However, the core of a fast reactor is compact. It contains no moderator so that the fission neutrons are not slowed down and retain fast speeds. Because of the nuclear properties of the fuel (which in this case is plutonium) this produces advantageous results which are not available with the technology of thermal reactors.

The central core region of a fast reactor consists of a core of mixed uranium-plutonium oxide fuel surrounded by a "blanket" of uranium oxide. The uranium in both core and blanket is uranium-238, which is a waste product from an enrichment or reprocessing plant. The core and blanket are shown schematically in Figure 11. It is worth perhaps looking for a moment at the technology that goes into this fuel cycle. Figure 12 shows in more detail the components in the established fast reactor fuel cycle which has already been shown schematically in Figure 9. We see from Figure 12 that the spent fuel, when it is discharged from a fast reactor, is first allowed to "cool" for a number of months, during which time the shorter-lived fission product activity has time to decay, making the fuel easier to process subsequently. Thereafter, the fuel passes to the reprocessing plant, where it is chopped up and the uranium, the plutonium and the fission products are leached out in a strong nitric acid solution. This solution is then subjected to a process of solvent extraction, which allows the separation of the uranium and plutonium, (which dissolve in the organic solvent), from the fission products (which dissolve in the aqueous phase). The fission products are removed in low-, medium- and highly-active waste streams, for each of which there are appropriate waste management techniques. The intention with the highly-active waste stream, which constitutes only a very small


Axial Blanket
Plutonium Core
Depleted Uranium
Axial Blanket
Radial Blanket
Plutonium Core
Depleted Uranium

Figures 11A and 11B The core and blanket regions of a fast reactor

percentage of the total volume of material recovered from the spent fuel, is that it should be incorporated into blocks of very stable, very leach-resistant glass by a vitrification process and enclosed in corrosion resistant containers. In this form it will then be possible to dispose of the wastes either into a geological repository or, possibly, to the deep ocean bed.

The uranium and plutonium, which are extracted in the organic phase, are subsequently refabricated into fuel. New methods are under development at present aimed at an improved fabrication process using the gel precipitation technique. Under the right chemical conditions, the droplets of one fluid, being poured into another will form into nearly perfect spheres, and it is possible in this way to precipitate spheres of uranium and plutonium mixed in a proportion suitable for use as fast reactor core fuel. The fabrication process involves making spheres in two or three different sizes which are sintered. We pass then to the pin-filling stage of the process, where the sintered spheres are inserted into fuel element cans using a so-called "vibrocompaction process", the element being ultrasonically vibrated, so that the smaller spheres infiltrate among the larger ones and pruduce a fuel of the requisite high density. This, in a few words, is the process by which the spent fuel will be refabricated into fresh fast reactor fuel, thus completing the

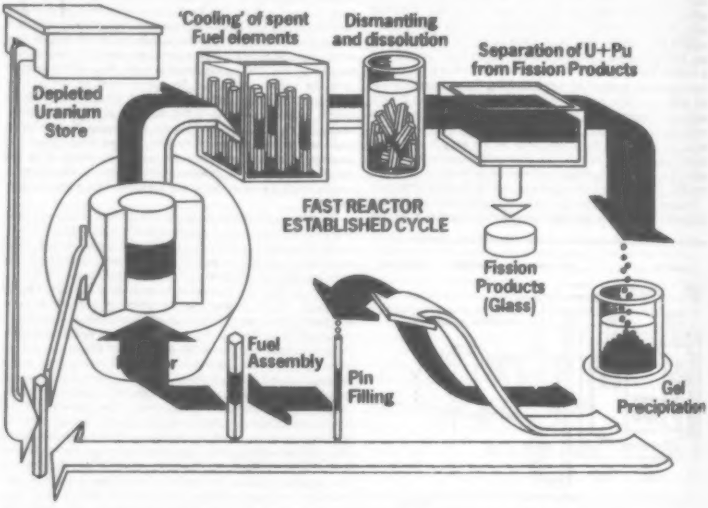

'Cooling' of spent Fuel elements
Dismantling and dissolution
Separation of U+Pu from Fission Products
Depleted Uranium Store
FAST REACTOR ESTABLISHED CYCLE
Fission Products (Glass)
Fuel Assembly
Pin Filling
Gel Precipitation

Figure 12 The components of the established fast reactor fuel cycle shown schematically in Fig. 9

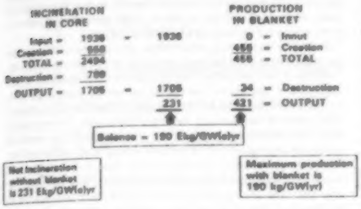


Figure 13 The plutonium balance sheet for a fast reactor

cycle.

Let us now look at the balance sheet for plutonium creation and incineration in the fast reactor fuel cycle. During the operation of the fast reactor, there is a steady net incineration of plutonium in the core. At the same time, however, the neutrons which escape from the core are captured by the U-238 in the blanket to make a stock of plutonium by the process we have discussed earlier. You will remember that in Figure 1 we gave a balance sheet for plutonium production in a thermal reactor. But a thermal reactor only has a core whereas the fast reactor has a core and a blanket, the plutonium balance sheet for a fast reactor is, therefore, more complex and is shown in Figure 13. As before, weights of plutonium are again measured throughout in terms of Pu-239 equivalent.

We need to look at the balance sheet of Figure 13 very carefully because it tells us a great deal about the operation of the fast reactor. There are a number of fast reactor designs and, depending upon the design, the figures in this balance sheet can vary somewhat. However, these figures are broadly typical of sodium-cooled, oxide-fuelled fast reactors as contemplated worldwide at the present time. Concentrating first on the figures on the left-hand side which concern incineration in the core, we see that the input to the fast reactor is 1936 Ekgs of plutonium and, during the course of operation (1000 MWe operating for 365 days) an additional 558 Ekgs of plutonium are created from the uranium-238 in the core to give a total of 2494 Ekgs. However, more plutonium is destroyed than is created. The total destroyed is 789 Ekgs giving a net output of 1705 Ekgs. For our immediate purposes, we can forget about the details of creation and destruction in the core just as we did for a PWR and simply note that, for a fast reactor, the input is 1936 Ekgs and the output is 1705 Ekgs, giving a net incineration of plutonium in the core of 231 Ekgs.

Meanwhile, however, we have the option of producing plutonium in the blanket. The plutonium input to the blanket is zero. 455 Ekgs are created, 34 are destroyed in situ giving a net output from the blanket of 421 Ekgs.

A balance between the incineration of 231 Ekgs in the core and the production of 421 Ekgs in the blanket is a net balance of 190 Ekgs. This last figure is to be compared to the net production from the PWR of 270 Ekgs, from Magnox of 617 Ekgs, from CANDU of 493 Ekgs and from the AGR of 173 Ekgs.

The incineration of plutonium in the core is inevitable: after all the fast reactor is designed to operate by incinerating plutonium. The production of plutonium in the blanket is optional. A smaller blanket would have produced less plutonium and, if we put less uranium-238 in the blanket, we will produce less plutonium. In short, with this particular design, we can end up with any figure between an incineration of 231 Ekgs and a production of 190 Ekgs and, whether overall we get incineration or net production, the figure is lower than the equivalent figures for thermal reactors such as the PWR, CANDU or Magnox. It follows, therefore, that the fast reactor is not a copious producer of plutonium when compared to thermal reactors. That must be the case because its operation depends heavily upon incineration of plutonium in the core. In short, fast breeder reactors do not breed fast, they simply use fast neutrons and breed rather slowly.

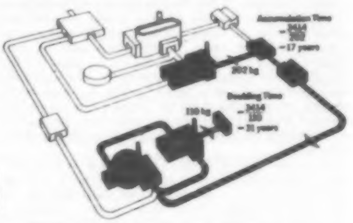


Figure 14 Plutonium inventory and production

The numbers given in Figure 13 now enable us to understand the operation of a fast reactor. The first step in the operation is to accumulate enough plutonium to start it off. At first sight, that would seem to require 1936 Ekgs but actually it requires much more than that for reasons we will come to in a moment. At the end of a suitable time interval, say a year, so much plutonium has been incinerated in the core that it is necessary to replenish it. This can be done by removing fuel elements from the core and replacing them by fresh fuel elements. To manufacture the fresh fuel elements we initially need more plutonium from a stockpile. Once the fast reactor is launched, however, the plutonium to make fresh fuel can be obtained by removing the blanket fuel elements and extracting the plutonium from them. The fast reactor fuel cycle therefore amounts to shuffling the plutonium from the blanket into the core on a regular basis and continually replenishing the blanket and core with depleted uranium, i.e. uranium-238, which is otherwise simply a waste product. The dissolution of the fuel elements, the separation into uranium, plutonium and fission product streams, and the subsequent reconstitution of core fuel elements are done in the fast reactor fuel plant which is a combined reprocessing and fuel fabrication facility and shown symbolically in Figure 9. We end up then with a fuel cycle which in effect has only one input in the form of depleted uranium, and two outputs: vitrified waste and electrical energy.

As we have seen, some time is needed before the fast reactor is fully self-sustaining. The plutonium needed to launch the fast reactor is therefore not just the 1936 Ekgs we put in the first charge of the fuel but, in addition, the plutonium which is needed to replenish that fuel until that fast reactor fuel cycle is properly established. The total plutonium inventory is, then, the plutonium in the core, the plutonium in the spent fuel elements which have recently been removed from the core, and the plutonium in the reprocessing and fabrication plant which is in the process of being recycled back to the fast reactor. This total inventory of plutonium is therefore substantially larger than the input shown in Figure 13.

The inventory of plutonium required to sustain a fast reactor depends upon the load factor that we assume for it. So far all the figures I have quoted have been in units of GW(e)y, corresponding to the operation of a 1000 MWe reactor for 365 days. The figures quoted so far are therefore independent of load factor and the most precise ones to use for comparing one reactor type with another. To take the argument another step forward we must assume a load factor, and for simplicity I shall assume that all reactors, whether fast or thermal, operate at a 75 per cent load factor. Allowing for that and allowing for a technical operation of the fast reactor fuel cycle in the way described more precisely in Appendix B, we arrive at Figure 14 which shows the total inventory of plutonium in the fast reactor fuel cycle to be 3414 Ekg, the excess plutonium produced each operating year to be 110 Ekg, and on the equivalent basis the excess plutonium from the thermal reactor to be 202 Ekg

Notice from Figure 14 that, because there is a net production of 110 Ekgs, it follows that, after a time of 31 years, we would have enough plutonium, 3414 Ekgs, to provide the total inventory needed to launch a new fast reactor. This latter time is called the "linear doubling time". It is the time that it takes one fast reactor to breed enough plutonium to start off another fast reactor. It is this possibility which gives rise to the name "breeder" reactor, but we see that the breeding characteristics of the fast reactor are not actually very important. What is important in the long term is that the fast reactor is self-maintaining. We shall return to the importance of this point later in the lecture.

The numbers given in Figures 13 and 14 are, as we have noted, those for a particular fast reactor design and fast reactor fuel cycle. There is, however, an infinite variety of fast reactor concepts and each concept produces slightly different figures. A selection of figures is shown in Figure 15 and the table gives a fair impression of the variety of fast reactor concepts which are under consideration at present. Further details are given in Appendix II. Looking carefully at Figure 15 we note that the example given earlier is in the third Column and corresponds to fast reactors which could be in operation early next century. The most rapid plutonium production, roughly matching that from a PWR, is given in Column 6 but our present judgement is that that would require further research and development, coupled with practical experience of the fast reactor fuel cycle, before it could be realised. It should be noted that only for three out of these six designs is the net annual production of plutonium any greater than that from an AGR and that in all cases it is considerably less than that from Magnox or CANDU. In no case, therefore, does the fast breeder reactor breed plutonium rapidly.

We should note in passing that there are some fast reactor concepts which do breed plutonium rapidly, but they are not likely to be of any major practical interest for the foreseeable future. The fast reactor which uses metallic fuel would breed plutonium rapidly. It is widely agreed, however, that there would be no economic advantage in using metallic fuel, and there are at present no known commercial fast reactor programmes based on this type of fuel. If carbide fuel were used in place of oxide fuel then again the fast reactor would breed more rapidly, probably producing plutonium at a rate more comparable to Magnox or CANDU reactors; however, the problems of using carbide fuels are formidable and, therefore, the possibility of doing that must be regarded as an option which, if it materialises at all, will do so only in a late generation of reactors using advanced technology.

Given this background information, we can now summarise the key characteristics of fast reactors in the form shown in Figure 16.

We have now completed our discussion of the operation of fast reactors and fast reactor fuel cycles and we are ready to go on to consider the implications of those technical facts for the economic deployment of fast reactors and, most importantly, for their use to assist non-proliferation objectives. The key facts we need to remember are that we cannot normally start up a fast reactor until we have a large inventory of plutonium to launch it and that that plutonium must come from the operation of thermal reactors. We also note that the excess plutonium bred by a fast reactor is produced relatively slowly and, therefore, although each fast reactor is self-sustaining, it cannot breed additional fast reactors rapidly.

Economic value of plutonium

You will remember that, in the introduction of this lecture, I said that no lasting non-proliferation regime can be based upon a policy of denial and it was important that any stable (or slowly evolving) regime be constructed so that the economic self-interest of all countries was not infringed. We must now turn to a consideration of the economic value of fast reactors to various countries and that in turn will drive us to consider the economic value to be attached to plutonium once fast reactors are established. We shall show in this discussion that the technical facts discussed so far determine an economic value for plutonium and spent fuel which in turn provide us with scope for making a significant contribution towards a viable non-proliferation regime. At the same time I should stress again that no technical or economic solution can ever serve as more than a partial answer to what is fundamentally a political problem. We must always keep in mind the importance of developing not only technical opportunities but also the political and institutional measures that will allow us to turn them to good account.

Let us then look at the economics of plutonium use. Obviously the

	DESIGN 1	DESIGN 2	DESIGN 3 Reference	DESIGN 4	DESIGN 5	DESIGN 6
PLUTONIUM INVENTORIES kg Pu E 239/GWe						
In-pile inventory at equilibrium	2940	2350	2230	2230	2060	2640
Fuel cycle inventory at 75% load factor	2334	1228	1184	1042	1628	1368
Total inventory	5274	3578	3414	3272	3688	4008
PLUTONIUM FLOWS kg Pu E 239/GWe yr						
Input	1921	2050	1936	1739	2735	2160
Core	-174	-254	-231	-306	-282	-99
Blanket	+347	+404	+421	+434	+460	+405
Output	2094	2200	2126	1867	2913	2466
Net production	+173	+150	+190	+128	+178	+306
After reprocessing (Allows for some Pu held in process plant residues)	+131	+107	+147	+91	+120	+293
Equilibrium doubling time at 75% load factor years	53·4	44·8	30·9	47·9	41·2	18·2

DESIGN 1 assumes 18 months out-of-pile time, 2 fuel cycle batches, a core height of 1·2m and a mass rating of 229 MW (t) tonnes of heavy atoms

DESIGN 2 includes an increase in the number of fuel cycle batches, a decrease in the time the plutonium spends in the cycle and a decrease in fuel pellet diameter compared with Design 1

DESIGN 3 is Design 2 with decreased core height

DESIGN 4 is Design 3 with decreased core fuel density and increased core burnup

DESIGN 5 is Design 3 with decreased core fuel density and decreased core burnup

DESIGN 6 is Design 5 with decreased mass rating, decreased can thickness, increased axial breeder height and reduced plutonium held in residues

Figure 15 The variation of design parameters for fast reactors

FAST BREEDER REACTORS

1 **Do not breed fast**

2 **Use fast neutrons and breed slowly**

3 **Mostly they incinerate plutonium**

4 **Core is an incinerator**

5 **Blanket (optional) is producer**

6 **The balance between incineration and production is delicate**

Figure 16 The key characteristics of fast reactors

economic value to be applied to plutonium depends upon the extent to which it is available and upon the use we make of it. Earlier in this lecture we identified several possible fuel cycles. They were as follows:

The once-through cycle (Figure 2)
The reprocessing cycle (Figure 5)
Thermal recycle (Figure 6)
The fast reactor launch cycle (Figure 8)
The fast reactor established cycle (Figure 9)

Let us now consider the economic value to be attached to plutonium for each of these fuel cycles taking them one by one.

For the once-through cycle, the plutonium exists only in a spent fuel element, it does not exist in separated form. In this cycle, therefore, the plutonium and the spent fuel elements have no immediate value at all, they are a liability to whoever possesses them. Since the uranium and plutonium which are contained in the fuel element have got a potential value, it follows that the spent fuel element itself has a potential value. However, it is possible to deduce that value only by considering the spent fuel element as an input to some other fuel cycle and it is, therefore, something we should deduce only when we have completed the discussion of those fuel cycles.

Looking next at the reprocessing fuel cycle shown in Figure 5, we note that the separated plutonium is not used at all but simply stored. If that cycle is operated, therefore, then the immediate economic value of the plutonium is zero (or slightly negative if storage costs are taken into account).

Looking next at thermal recycle shown in Figure 6, we observe that the plutonium is used as a replacement for uranium fuel and therefore, if that fuel cycle is used, the plutonium has some value as a replacement fuel. Figure 7 showed that plutonium used in this way produces an economy of at most 16 per cent of the uranium used in a thermal reactor. The annual production of plutonium is therefore worth, on average, no more than 16 per cent of the annual input of uranium fuel. This is not a very large figure and in practice would anyway be a significant overestimate, the saving on purchase of fresh uranium, and on enriching it, being offset by the higher cost of fabricating plutonium-bearing fuels. Another disadvantage, but one which is not easy to quantify, is that the waste produced from using plutonium in a thermal reactor has a larger percentage of long-lived actinides than the waste produced either by a uranium-fuelled thermal reactor or by a fast reactor. For these reasons, partly quantifiable and partly non-quantifiable, the incentive to trade plutonium between a producer and a user, either in one country or internationally is small — in contrast, as we shall shortly see, to the situation with fast reactors. Plutonium in short has most value to the utility that produces it but even that is modest and somewhat less than the replacement value for uranium fuel.

The situation is dramatically different if we look at the fuel cycle to launch the fast reactor shown in Figure 8. The economic value of a fast reactor follows from the fact that, once launched, it is effectively self-sufficient. It needs no annual input of either natural uranium or fresh plutonium: it manufactures its own fuel in the way described in the previous section using only a small feed of uranium-238 which is a freely available material with no alternative uses. We noted earlier that the fast reactor uses liquid sodium and has an intermediate sodium circuit. We must accept, therefore, that its capital cost will be higher than that of a thermal reactor. Comparing fast reactors to thermal reactors, therefore, we have a higher capital cost, a negligible replenishment of fresh fuel, and lower fuel fabrication and reprocessing costs, leading to prospectively a lower overall cost per unit of electricity generated. As uranium becomes scarcer in the world, leading to greater concern about its future availability and price, eventually the fast reactor must come to be seen as the most economic choice for nuclear electricity generation. In practice this point will come at different times in different countries, depending upon their different levels of technological development, their different patterns of investment in nuclear and fuel cycle plant, and on other considerations. Before such time as fast reactors come to be seen as economic, the plutonium has little or no immediate economic value, since as we have seen, its value in thermal reactors is not great. However, once the fast reactor has become preferable to the thermal reactor, then the plutonium acquires an immediate economic value. We can determine what that economic value ought to be by the following analysis which uses the results of Figure 14.

Suppose first that a country such as the United Kingdom, France, Germany or the US were to launch a programme of fast reactors because they assessed it would be economic to do so compared to the alternative of continuing to install new thermal reactors and to import ever-increasing quantities of uranium ore year by year to keep the thermal reactors operating. Then, whatever the incentive towards fast reactors, the programme cannot be very large because, as we saw in the previous section, every fast reactor needs a large inventory of plutonium to launch it. Figure 14 shows that to launch a single fast reactor we need to have operated a thermal reactor for 3414/202 years, i.e. 17 complete years. The number of fast reactors which can be launched is therefore limited by the past experience of the country in operating thermal reactors. For example, in the report of the Windscale Inquiry, Mr Justice Parker calculated that the United Kingdom would have enough plutonium in stock from Magnox reactor operation by the year 2001 to launch the equivalent of ten 1000 MWe fast reactors by that date. If indeed fast reactors bred plutonium copiously, this would not be an important point because the first few fast reactors built would then breed plutonium rapidly enough for more fast reactors to be built and they, in turn, would breed more plutonium etc. (This indeed is the impression given in some parts of the popular Press when they discuss fast reactors). However, as we stressed in the previous section, the core of the fast reactor is such an efficient incinerator that the net production of plutonium in a fast reactor is necessarily limited. The numbers given in Figure 14 show that it would take a fast reactor 31 years to accumulate enough plutonium to start a fresh fast reactor.

We conclude, therefore, that even when it is econonomically desirable to build more fast reactors, there is a sharp limit to the degree to which this can be done because the plutonium is simply not available to launch them. We cannot, therefore, ever have a crash programme of fast reactor construction. The choice, using our own plutonium stocks, is simply that between building fast reactors very slowly now, or building them slowly later on. (There is, as I indicated earlier, the technical alternative of launching fast reactors using U-235 but only at the cost of a considerable increase in the early requirement for enriched uranium). It is for this reason that nearly every analysis concerning the introduction of fast reactors postulates the simultaneous construction and operation of thermal reactors in order to minimise the disadvantages posed by the lack of plutonium supplies.

There is an important limitation to this analysis. It assumes that, in the countries we are discussing, there is a continued growth in the demand for nuclear electricity. This growth could be due to an overall increase in electricity demand, or to the substitution of nuclear reactors for fossil stations which have completed their working lives. Provided the demand for nuclear electricity in a country is expanding, then the remainder of the argument follows. There is a limitation to the validity of the argument if the growth of electricity demand in a country falls to very low levels. This rather complex point is discussed in more detail in Appendix III. In the remainder of this lecture I shall set aside this last complication, which in my opinion is unlikely to occur in practice. We have concluded that any country that launches fast reactors would run up against the bottleneck of plutonium availability. Once that happened, there would be an economic incentive for that country to begin to trade with a country which was not operating fast reactors, with a view to acquiring the latter's spent fuel, and then reprocessing it to obtain the plutonium it needs to launch further fast reactors. Furthermore, the country without fast reactors would see an advantage to such a trade because spent thermal fuel is actually a liability (it has to be stored and guarded) and trading it off gives an economic value which can be set against further purchases of uranium ore. Both countries with fast reactors and those without fast reactors therefore benefit from their existence. That benefit essentially comes from the earlier use of spent thermal fuel than would be permitted on average if every country strove for "plutonium independence".

This mutual economic benefit, which is a natural consequence of international trade in spent thermal fuel, also assists an international non-proliferation regime because it concentrates, on a voluntary basis, the use of plutonium and fast reactors in a limited number of countries. But the advantages of this international trade are more profound than that because a trade in spent fuel does not merely produce an economic benefit to both participants in the trade; we shall show later that a fair and equitable trade produces equal economic benefits to the participants. In this case we have produced the remarkable conclusion that fast reactors can benefit equally those countries that have them and those that do not! We have therefore produced an incentive for those countries which have fast reactors to build more, and those which do not have fast reactors to avoid their use altogether. This assists our non-proliferation objectives still further because if such a regime could be set up and maintained the majority of countries in the world, which would be those with small programmes, would in their own self-interest avoid the use of fast reactors. In consequence we would have fast reactors (and plutonium) used in countries with big nuclear programmes and thermal reactors (and no plutonium) used in countries with small nuclear programmes. The regime would be sufficiently stable from an economic point of view that it would change only slowly as countries evolved from "small programmes" to "big programmes".

In order to determine the fair and equitable trading relationships for spent fuel and plutonium I would first ask you to make the imaginative step of supposing that we had in this country two utilities we can call the Thermal Reactor Utility and the Fast Reactor Utility. The Thermal Reactor Utility, would, as its name implies, use only thermal reactors for producing electricity, and would, we shall assume, simply store the spent fuel which has been derived from its operations, the Fast Reactor Utility would by contrast be operating a limited number of fast reactors, having started these up initially with thermal reactor plutonium, but now recycling the plutonium so as to keep their stations in operation, and slowly breeding more so as to be able to start up new stations. We assume the Fast Reactor Utility, which is independent of any imports of fissile material to maintain operations, is able to generate electricity more cheaply than can the Thermal Reactor Utility which needs to import expensive uranium ore.

Let us now suppose, moreover, that both of these utilities sell their electricity to a distribution company which operates on a nationwide basis and markets the electricity to the consumer. The consumer will naturally enough be indifferent as to whether the electricity he uses comes from fast or from thermal reactors, and the distribution company will not distinguish between thermal and fast reactors in the charge it makes for electricity. This we can assume will reflect the average level of generating cost achieved by the two utilities together. In a situation where the Fast Reactor Utility is generating more cheaply, we would normally expect a gradual but significant degree of market penetration to occur. Indeed such a process of gradual penetration is what both utilities would expect and desire. Although the Thermal Reactor Utility will continue to operate its stations, and will order new stations in due course, both utilities would expect a large proportion of the national replacement capacity and a significant proportion of the capacity needed to meet load growth to consist of fast reactors. However in this instance the

INFCE: THE FINAL COMMUNIQUE

The International Nuclear Fuel Cycle Evaluation (INFCE) was initiated at an organising conference held in Washington, D.C. in October 1977. The Communiqué of that conference said the participants

- were conscious of the urgent need to meet the world's energy requirements and that nuclear energy for peaceful purposes should be made widely available to that end;
- were convinced that effective measures could and should be taken at the national level and through international agreements to minimise the danger of the proliferation of nuclear weapons without jeopardising energy supplies or the development of nuclear energy for peaceful purposes; and
- recognised that special consideration should also be given to the specific needs of and conditions in developing countries.

Participation in INFCE was open to all interested States and relevant international bodies. In the event 66 countries and five international organisations took part. They included industrialised and developing countries; countries with larger or smaller nuclear programmes at various stages of advancement; consumers and suppliers of materials, technology and equipment; market and centrally-planned economies; nuclear and non-nuclear weapons States; parties to the Euratom Treaty, the Non-Proliferation Treaty and the Tlatelolco Treaty and parties to none of these; and countries from all geographical regions.

A Communiqué issued after the final plenary conference of INFCE, which took place in Vienna in the last week of February 1980, said the participants "considered that INFCE has accomplished its task. It has identified ways and means of strengthening assurances of nuclear supply while at the same time minimising the risk of the proliferation of nuclear weapons," which would involve "international cooperation and include technical, legal and institutional measures as well as possible developments in the field of safeguards." As one of its assigned tasks INFCE had analysed the special needs of developing countries, and had pointed to actions that might be taken by States through the International Atomic Energy Agency and to other means to meet those needs.

Delegates to the final plenary conference "recognised the central role that the IAEA has played in the past and must continue to play in the future in meeting the problems that were the focus of the INFCE study"; they noted with satisfaction that the reports of the various working groups which had been set up to consider specified aspects of the fuel cycle "were presented to the Plenary Conference without separate or dissenting views," though as with all consensus documents this did not mean that every Working Group member was in full agreement with every word or endorsed in every case the particular form of expression chosen.

The Communiqué went on "Environmental, health and safety issues

Fast Reactor Utility can only penetrate the market as fast as is desired by acquiring spent fuel from the Thermal Reactor Utility from which to produce plutonium.

The price to be paid for that spent fuel is, in this case, easy to determine: it is simply that payment which, added to the launch cost of fast reactors and credited to the running costs of thermal reactors, makes the price of electricity from fast and thermal reactors identical. Thus as the cost of thermal reactor electricity increases with rising uranium prices, there would be a corresponding increase in the price of spent fuel. This is entirely fair and equitable because the division into two utilities, fast and thermal, was an arbitrary choice in this case.

As another step of the imagination, suppose spent fuel were traded internationally in a free market with several countries operating fast (plus thermal) reactors and many others operating only thermal reactors. Then if the asking price for spent fuel was too high, the "fast" countries would build more thermal reactors; if the asking price for spent fuel were too low, "fast" countries would rapidly absorb it in their eagerness to use it to build more fast reactors. There is an ideal equitable price for spent fuel, which should be such as to make the cost of nuclear electricity the same in both "fast" and "thermal" countries — within the limits that "costs" can be defined.

Of course I do not actually advocate that there should be a free market in spent fuel free from all international controls. That indeed could be regarded as a significant proliferation hazard. I accept that it is essential that the use of plutonium must be accompanied by the development and implementation of institutional arrangements such as IAEA safeguards on spent fuel and plutonium. I also accept that national arrangements for the physical protection of plutonium in use and in transit should be based on IAEA-approved procedures. There is also a strong case for the implementation of an IAEA scheme for the international supervision of separated plutonium throughout the world. The use of material must be carefully monitored from reactor to reprocessing plant, to fabrication plant and back to reactor once again. Assuming, however, that this carefully controlled, monitored and supervised trade in spent fuel does take place the considerations I am describing here cover the financial transactions which must necessarily take place in parallel. From the preceding discussion it is now possible to see how the "fair and equitable" price for spent thermal fuel can be arrived at. But because the economic formulae needed are rather complex I have summarised them in Appendix III.

Non-proliferation implications

The analysis of the preceding section has shown that if a few countries choose to launch fast reactor programmes early next century, then economic forces are created both for those countries and for other countries which choose to operate only thermal reactors. Those economic forces result in the retrieval of plutonium into the "fast reactor countries". However, this is exactly what a non-proliferation regime would seek to accomplish! We have at no time relied on coercion and we have at no time dictated to any country what its policy ought to be. Our policy has been a voluntary one, which should be economically acceptable to the countries involved. Unfortunately, the fact that this pattern of behaviour could or should exist does not determine that it will actually happen but, as I stressed at the outset of this lecture, there is no technical gimmick which will "solve" the proliferation problem, because the question of proliferation is primarily political and can be solved only by the exercise of political will and international diplomacy. All that we scientists can do is, therefore, to point to the best technological options to support political convictions to avoid proliferation throughout the world.

If we look at the manner in which the nuclear fuel cycle has evolved in various countries of the world we will find that the pattern we can expect is one of gradual progression. Countries, beginning by operating thermal reactors, only evolve with time towards the acquisition of the complete thermal reactor fuel cycle with enrichment and reprocessing plants. In the fullness of time a few countries will take the step of installing fast reactors and fast reactor fuel cycle plants. At any one time different countries will be at different stages in this progression with, for example, only limited numbers of countries operating their own reprocessing capacity. And this indeed is a desirable situation from an economic point of view.

In reprocessing plants built to treat the spent fuel from thermal reactors, there is a considerable benefit from large-scale operation. Therefore, if a few countries build large reprocessing plants and if those countries offer a service to other countries, then, provided it is sensibly priced, it is in the economic self interest of the majority of countries not to have their own reprocessing plant but to rely upon that service. Herein lies indeed an additional economic advantage

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were addressed by the Working Groups within their terms of reference, to determine whether specific fuel cycle activities could be carried out in conformity with accepted standards. Study of these problems showed that these standards could be respected. More comprehensive environmental, health or safety assessments are being undertaken in other national and international forums, particularly within the IAEA.

"The reports do not contain policy recommendations, because INFCE was intended as a non-political, technical and analytic study rather than a negotiation. The delegates agreed that the INFCE reports had made an important contribution to the definition of problems within their fields of study and had produced valuable suggestions, and that INFCE had reduced differences of view and promoted common understanding among the participants."

At the conclusion of debate at the Final Plenary Conference the following actions were taken:

- The Conference "received the reports of the Working Groups and the summary and overview, and submitted them to governments of participating States for their consideration in developing their nuclear energy policies and in international discussions concerning nuclear energy cooperation and related controls and safeguards, recalling that participants are not committed to INFCE's results under the terms of the [earlier] Washington Communiqué. It resolved furthermore that these reports should be made available to all governments and international organisations and conferences interested in the peaceful uses of nuclear energy."
- It decided that the Evaluation had been completed, and discharged the Working Groups and the Technical Coordinating Committee with thanks and congratulations on the high quality of their work.
- It thanked the IAEA for the "outstanding quality" of the technical and administrative support it had given to the study.
- And it declared that INFCE was now at an end, and that the Working Group reports and the Summary and Overview should be released to the public.

The Communiqué concluded:

"Finally, the Conference wishes to state that the findings of INFCE have strengthened the view:

- that nuclear energy is expected to increase its role in meeting the world's energy needs and can and should be widely available to that end;
- that effective measures can and should be taken to meet the specific needs of developing countries in the peaceful uses of nuclear energy; and
- that effective measures can and should be taken to minimise the danger of proliferation of nuclear weapons without jeopardising energy supplies or the development of nuclear energy for peaceful purposes.

"The Conference recognised that the objectives mentioned above can only be achieved through continued international cooperation and the participants are determined to preserve the climate of mutual understanding and cooperation in the international nuclear energy field that is one of the major achievements of INFCE." □

from the concentration of fast reactors within a limited number of countries. This also is a policy which builds up interdependence between nations in the handling of spent fuel and plutonium. The exact pattern in which reprocessing plants, fast reactors and fast reactor fuel cycle plants become distributed in the world is not, of course, foreseeable at the present point in time. A whole range of options is possible and every government will make its own decision on the facts as it sees them. I have assumed however that a number of countries will set up big reprocessing plants and offer an economical service to the rest of the world. The existence of that service permits "trade" to take place in spent thermal reactor fuel, and in fast reactor fuel assemblies. Once those two steps have been taken, for a long time it will be in the economic self-interest of the smaller countries to operate thermal reactors and *not* have either reprocessing plants or fast reactor plants of their own.

The proposals fail if either reprocessing plants or fast reactors are delayed too long: they fail if those countries with reprocessing plants do not give a sensibly priced service to other countries: and they fail if those countries operating fast reactors do not give fair value for the spent thermal reactor fuel they require. And they fail in the absence of a sufficiently secure uranium market, offering adequate guarantees of security of supply to the thermal reactor countries. The proposals in this lecture also require the use of appropriate international arrangements to ensure that plutonium and spent fuel cannot be diverted undetected from civil nuclear programmes. We have the time for them to evolve properly but, unless the role of the fast reactor is better understood than it is at present, there is a danger that every government will strive for nuclear power independence instead of nuclear power interdependence.

The proposals I have made have avoided coercion, have not used a policy of denial and have suggested a degree of international interdependence which is both economically attractive and must surely be a political incentive to support co-operative policies on non-proliferation.

Philosophical reflections

In this lecture today I have reviewed technical facts concerning plutonium and fast reactors and I have shown how those technical considerations can lead to an economic regime involving international trade in spent thermal reactor fuel which benefits equally those countries with fast reactors and those without them. It also assists in avoiding the proliferation of nuclear weapons. But it is possible to take this discussion beyond technology and economics to consider questions of ethics.

The developing countries of the world hope to improve the lot of their people through industrialisation and improved agricultural practice. Both require energy. The advanced countries of the world are already close to exhausting mankind's oil reserves before the majority of mankind, in the developing countries, can afford to use them. That is not an ethical behaviour. The advanced countries are now heading towards exhaustion of mankind's accessible uranium reserves before the developing countries have a chance to use them either. The long term future lies with fast reactors, and our objective must be to get them operating before the remaining uranium becomes too expensive. I have suggested that our objective must also be to operate them in such a way as to maximise the benefit to all countries: this involves increasing their interdependence.

The usual argument that has been advanced in favour of fast reactors is that they lead to "energy independence" for the country operating them. That is an important advantage and it is not one that I am seeking to any serious extent to undetermine. It must be understood however, that for the short term at any rate, energy independence is possible only in relative rather than absolute terms. As we have seen, a country that is beginning to launch fast reactors still has to continue to build some thermal reactors so as to get the supply of plutonium it needs for the extension of its fast reactor programme. In other words the phasing in of fast reactors and the phasing out of thermal reactors is a process which is spread over several decades. What I am suggesting is that the process should be optimised, not so as to maximise energy independence, but rather so as to help all nations simultaneously. All this means in practice is building slightly more fast reactors and fewer thermal reactors in the "fast countries" than they would do if seeking simply to achieve maximum "energy independence".

To look at this another way: a country introducing fast reactors will nevertheless plan upon uranium imports for the thermal reactors it continues to operate alongside the fast reactors. I advocate that it should plan to reduce somewhat its dependence on uranium imports, and to introduce a corresponding dependence on spent fuel imports, so as to be able to launch a few more fast reactors in the place of thermal reactors.

This is only a shading of the usual arguments concerning fast reactors; but it does create an option for countries with small nuclear programmes without fast reactors to avoid the use of plutonium indefinitely, or certainly for a long time, without suffering an economic penalty.

The scheme that I have outlined depends for its success on finding a fair and equitable price for spent thermal reactor fuel and the determination of that price is a complex matter which I have not been able to discuss today. The arguments given earlier and write large in Appendix III shows that this fair and equitable price is related to the economic advantage of the fast reactor over the thermal reactor for any given uranium ore price. The argument has however been simplified to the extent that we are not dealing with a static ore price but with a dynamic one which will presumably rise over the lifetime of the reactor. Since forecasting future prices is difficult, it will not be easy for countries to reach agreement about what constitutes a fair price. The plan, moreover, will be acceptable to the thermal reactor countries only if, in addition to receiving fair value for their spent thermal reactor fuel, they can also have an assurance of an adequately secure uranium supply. The scheme I have outlined could therefore be improved if, instead of merely giving a financial value for the spent thermal reactor fuel, it would be possible to provide an assured supply of fresh uranium ore. How this can be best achieved is a matter for future consideration.

There are indeed many ways in which the scheme I have suggested may be criticised and there are many limitations to the simplified economic picture drawn. However, my judgement is that the scheme can be made to work if that is what governments want. If the economics and the demand for plutonium do not work out exactly as I have forecast, then there will be an economic penalty for countries to act as if they did. This penalty will, however, be trivial compared with the disadvantages of worldwide proliferation. To the extent then that uncertainties exist in the economics, our aim should always be to bias our estimates in favour of the countries not operating fast reactors so as to assure those countries, so far as possible, a secure market for their spent thermal reactor fuel.

The arguments I have used in this lecture have depended strongly upon technical facts which are frequently misunderstood or misrepresented in the public Press and I have not found it possible to work backwards and find out how these misunderstandings have arisen. Generally speaking, I and my technical colleagues must accept the criticism that we have not explained sufficiently clearly the operation of fast reactors and certainly, whichever technologist first called it the "fast breeder reactor", deserves a massive rebuke because the phrase "breeder fast reactor" would have been just as accurate and not capable of the same misinterpretation.

For fear of misunderstanding, nothing in this lecture proves the UK should build fast reactors *now*. I am quite sure we should build them at some time — but the timing of them depends upon a different set of judgements I have not mentioned at all. There is no point in launching fast reactors if it is uneconomic to do so. The burden of this lecture is that we must be sure to do so at the right time.

I have mentioned at the beginning of this lecture that scientists like myself have a responsibility to respond constructively to such political initiatives as INFCE and that this lecture should be looked at in that light. Many of the assessments and some of the thinking in this lecture owe a great deal to work which was done in INFCE or researched for INFCE. The use of plutonium in the fuel cycle was, of course, one of the central features of the Evaluation. The INFCE reports have been published and the Final Conference has taken place. Governments have now been presented with the most comprehensive international assessment of nuclear fuel cycles that has ever been made. It will take time for Governments to digest INFCE and it will take time before that is reflected in national policies. My lecture today, insofar as it looks to the future, is one scientist's view of the way in which plutonium could be used as a vital energy source and to produce the maximum economic benefit. It is not a Government view, but it is intended as a signpost to Governments that could lead to the responsible use of plutonium with the international community.

Acknowledgments

I would like to acknowledge the advice and help of many friends and colleagues in preparing this lecture. Many useful ideas have been incorporated from Sir John Hill, Lord Flowers, Dr Lewis Roberts, Mr Philip Searby, Mr Con Allday, Dr Donald Avery, Dr John Wright, Mr John Collier, Mr Myrddin Davies, Mr Tony Farmer, Mr Robin Nicholson, Dr Peter Jones and Mr Jonathan Heller.

I would also like to give a special acknowledgment to Mr Gerry Gibbons and Mr Peter Mills for their patience and help in putting together the figures to assist the text to the maximum possible extent. I have also benefited from discussions with Mr Ivor Manley of the Department of Energy, Mr Patrick Moberly of the Foreign and Commonwealth Office, and from discussions with Mr Tom Pickering of the State Department, Washington, and Dr Chauncey Starr.

This lecture formed the basis of a Discourse I gave at the Royal Institution in London on 29 February. For that presentation I would like to acknowledge the help given by many colleagues, some have already been mentioned above, and in addition Mr Colin Lyon, Mr Richard Sambell, Mr Eric Willmott, Mr John Darnell, Mr Peter Mulford, Mr Idris Jones, Mr Alan Burt, Mr Roy Bellamy, Dr Roy Nelson, Mrs Carolyn Mills, Miss Maggie Waters and Miss Paula Barnes.

APPENDIX I

"Equivalent" weight of plutonium

Throughout this lecture, reference has been made to the "equivalent" weight of plutonium, measured in units of Ekgs of plutonium, or kgs of Pu(E). This is likely to be an unfamiliar piece of terminology, and a few words of explanation may be in order.

The basic nuclear reaction of U-238 involves, as earlier described, the absorption of a neutron, to form U-239, which rapidly decays to Pu-239. Pu-239 is however not the only isotopic form in which plutonium exists in reactors. In practice an atom of Pu-239 can absorb a neutron to become Pu-240. The Pu-240 can absorb a neutron to become Pu-241, and in turn Pu-241 can become Pu-242. Although the chemical properties of all these isotopes are identical, the nuclear properties are totally different, and the number of fission neutrons produced in a given neutron flux may vary greatly from isotope to isotope. In either a thermal or a fast neutron flux, a given mass of Pu-240 will, for example, produce neutrons much less rapidly than an equal mass of Pu-239. This important difference in the physical characteristics of these various isotopes means that care is needed in specifying the weight of plutonium in any particular mixture, and has given rise to two different conventions.

One method is to quote a total weight of plutonium irrespective of the actual mixture of isotopes present, the plutonium weight then being measured in units of kgs of "Pu(T)". This was the convention which was adopted in the Graham Young Memorial Lecture, on the grounds that it was the simplest presentation possible. However, in technical literature the more customary convention is to measure not the mass of isotopes, but instead to measure their fissile worth. The measurement consists in quoting that mass of Pu-239 which equates in its fissile worth to the mixture of isotopes being measured, this "equivalent weight of Pu-239" being designated as the mass of "Pu(E)" or the mass measured in Ekgs. An Ekg of plutonium can weigh either more or less than 1 kg, depending on the proportions of the different isotopes in the mixture. The Ekg convention is the one that has been adopted here. The contrast between Pu(T) and the Pu(E) convention may be seen if we compare the figures quoted here for the Pu(E) production of a PWR with the Pu(T) figures quoted in the Graham Young Memorial Lecture.

PWR plutonium production per GWe-y

	Pu(T) kgs	Pu(E) Ekgs
Created	710	710
Destruction	380	440
Net Production	330	270

It will be seen that while the in situ creation figure of 710 kgs is the same in the two cases, since all the plutonium created is all Pu-239, the destruction figure is higher if measured in Pu(E) than if measured in Pu(T). This is because the Pu(E) figure takes account not only of the actual in situ fission of plutonium, the only phenomenon which is of significance in the Pu(T) balance, but takes account also of the conversion of the more fissile isotopes Pu-239 and Pu-241 into the less fissile isotopes Pu-240 and Pu-242. This process of conversion results in a net reduction in the fissile worth of the plutonium mixture, and is registered as a phenomenon of "destruction" in a calculation of the mixture's "equivalent" plutonium content.

It must be stressed at this point that neither of these two sets of figures is more "correct" than the other. Both of these methods of measurement are entirely legitimate ones, and the choice between them will depend very much on the context in which the weight of plutonium is to be quoted.

A more recondite point, but one which should perhaps be mentioned, is that there is not one universal measure of calculating "equivalent" weight of plutonium. The fissile worth of a mixture of plutonium isotopes, as compared to a unit mass of Pu-239, will depend on the reactor system in which this mixture of isotopes is assumed to be used. In particular the value of the "equivalent" weight can vary drastically from a thermal to a fast reactor. In this lecture the equivalent weights have been calculated for a fast reactor spectrum. The figures used throughout derive from a recent paper prepared by Mr A A Farmer and reproduced as Appendix II.

APPENDIX II

Plutonium production in fast reactors

By A A Farmer

In a fast reactor the neutrons inducing fission have an average energy of several hundred kilo-electron volts (keV) compared with an energy of less than one-electron-volt (eV) in a thermal reactor. When a fissile nucleus absorbs a neutron it generally reacts in one of two ways, it may undergo fission and liberate more neutrons, or it may retain the neutron to form a less fissionable higher isotope, e.g. U-236 or Pu-240, which require high energy neutrons (about 0.6 MeV) for fission. The number of neutrons released per neutron absorbed by the fissile nucleus is given by

$\eta = \nu\sigma_f/(\sigma_c + \sigma_f) = \nu/(1 + \alpha)$ where ν is the number of neutrons per fission and α is σ_c/σ_f, i.e. the ratio of capture to fission cross sections. On the η neutrons produced, one is required to continue the chain reaction, leaving $\eta - 1$ neutrons with the potential capability of converting fertile fuel atoms such as U-238 to fissile atoms by neutron capture. In practice some leakage and parasitic absorption in coolant and structural materials of neutrons takes place, so that a breeding ratio (i.e. ratio of fresh fissile fuel produced to the primary fuel destroyed), greater than unity is only possible if $\eta - 1$ is greater than around 1.1.

In the equation for η it is seen that ν and α are the important parameters. For the three fissile fuels U-235, U-233 and Pu-239, ν increases and α decreases with increasing neutron energy so that a higher value of η is achieved in a fast reactor spectrum than in a thermal one. However, the fissionability of all heavy nuclides is enhanced in fast reactors and an additional source of excess neutrons contributing to the breeding ratio is by fast fission of fertile fuel, e.g. U-238 which can contribute as much as 20 per cent of the power compared with around 2 per cent in thermal reactors.

Theoretically, a breeding ratio of around two is possible with a U/Pu-fuelled fast reactor although, as already mentioned, due to losses of neutrons on a practical engineering design by leakage and parasitic absorption, a value of 1.2–1.4 would be more typical. Of the fresh fissile fuel produced an equal quantity to the primary fuel destroyed is required to maintain operation leaving an excess for use in new plants. This excess over unity is the "breeding gain" and is dependent upon such factors of fuel design as rating, geometry and burn up as well as the amount of neutron absorbing materials in the reactor core. Some of the fissile atoms gained will, of course, be generated in the blanket outside the core.

Another important consideration of fast reactor logistics is the amount of fissile material needed for a reactor to produce a given power output at a given load factor, i.e. its inventory. This inventory comprises two parts — fissile material present within the reactor itself and fissile material outside the reactor in the fuel processing cycle. The former part depends particularly upon fuel rating and burn up achieved. The latter amount is dependent upon the rate fuel passes through the reactor (i.e. upon burn up and load factor) and also, in turn, upon the time taken to cool irradiated fuel to a level at which processing can be undertaken, upon the time to reprocess the fuel, and then to fabricate fresh fuel and transport it to the reactor.

The time taken for a fast reactor to produce enough plutonium to provide the total (i.e. in pile and out of pile) inventory required by a new reactor is known as the doubling time. It is proportional to total plutonium inventory and inversely proportional to its net plutonium production, the latter in turn depending upon breeding gain, the amount of plutonium not recovered from process residues and load factor.

Practical considerations

As fission cross-sections are relatively small at high neutron energies a high concentration of fissile fuel is required in the core of a fast reactor for criticality to be achieved. An infinitely large core, i.e. one with no neutron leakage, could go critical with about 7 per cent U-235 or 5 per cent Pu-239. In a practical case a fast reactor will require several hundred kilogrammes of fissile material at relatively high enrichment. Such concentrated fuel is expensive and in restricted supply so that the specific power (MW/t ha) must be an order of magnitude higher than in thermal reactors such as AGR and PWR if fast reactors are to produce competitive economic power. This necessity for a high power density in fast reactors in turn leads to a finely-divided core to provide a large heat transfer area and to the use of a non-moderating coolant with good heat transfer properties such as liquid metals. Even with fuel pins a few millimetres in diameter, fuel and core temperatures are high, so that a metal fuel tends to swell easily on the internal accumulation of fission product gases. This problem and the problem of achieving enhanced burn-up (the target being a peak burn-up of 10 per cent all heavy atoms) has led to the development of ceramic fuels such as mixed uranium/plutonium oxide canned in stainless steel, the latter being compatible with both fuel and coolant at high temperatures. Typical core parameters for an early 1250 MWe commercial reactor are indicated above:

Number of batches in fuel cycle	—	6
Fuel pellet diameter	mm	5
Can thickness/pellet diameter	—	0.075
Linear rating	W/mm	50
Mean mass rating	MW/the	330
Max core burn-up	% ha	10
Fuel density	% theoretical	80
Core height	m	1
Core diameter	m	2.66
Axial breeder height	m	2x0.4
Radial breeder thickness	m	0.4
Total sodium area/total core area	—	0.410
Fuel feed enrichment	% Pu(E)	17.0
In-pile inventory at equilibrium	kgPu(E)/GWe	2230
Out of pile inventory at 75% load factor and nine months Pu out-of pile time	kgPu(E)/GWe	1184
Breeding gain	—	0.306
Net plutonium production with 2% Pu in residues	kgPu(E)/GWe y	147
Equilibrium linear doubling time at 75% LF	y	30.9

Variations in plutonium requirements and production rate

Accepting that there will be practical engineering limits on core temperatures, pressure drops and coolant velocities, the characteristics of a large sodium cooled fast reactor can be varied in respect of the size of its specific plutonium inventory, its breeding gain (i.e. its excess plutonium production) and its doubling time by altering some of the basic core parameters.

Specific inventory decreases with

i increasing fuel burn-up — mainly due to decrease in out-of-pile hold-up.
ii increasing mass rating, brought about either by decreasing pin diameter at constant linear rating or increasing linear rating at constant pin diameter.
iii decreasing core height.
iv decreasing axial breeder height.
v increasing number of batches in the fuel cycle.
vi decreasing fuel density.
vii decreasing out-of-pile processing time.
viii decreasing fuel pin can thickness.

Breeding gain increases with

i decreasing burn-up.
ii. decreasing mass rating.
iii. decreasing core height.
iv increasing axial breeder height.
v. increasing number of batches in the fuel cycle.
vi increasing fuel density.
vii decreasing fuel pin can thickness.

To which can be added the fact that net plutonium production, which depends upon breeding gain, increases with decreasing plutonium losses from the fuel cycle during fabrication and reprocessing.

It is to be noted that as both a decrease in specific inventory and an increase in breeding gain lead to a reduction in doubling time, the search for the optimum means of reducing doubling-time involves a balance of core parameters that often work in opposite directions. Overshadowing the optimisation of the reactor core itself are the adverse effects on doubling-time of long plutonium hold-up times, and of the retention of plutonium in residues from the fuel processing plants.

The effects of changing the various parameters listed are tabulated in the table. The first column gives core parameters for a fast reactor with a 1.2 m high core and with mixed oxide 6 mm diameter fuel pellets achieving a maximum burn-up of 10 per cent heavy atoms: the reactor has a 2 batch fuel cycle and an 18 month plutonium out-of-pile time. The next three columns (2, 3 and 4) include changes in parameters which lead to a decrease in total plutonium inventory. The following two columns (5

Variations in fast reactor plutonium inventory and production rates

Parameter change(s) from Previous column			1	2	3	4	5	6
			—	**Pu holdup No. batches Pellet diameter**	**Core height**	**Fuel burn-up Fuel density**	**Fuel burn-up**	**Pu in residues Can thickness Mass rating Fuel density Ax. breeder ht.**
Technical specification								
Plutonium out-of-pile hold-up time		months	18	9	9	9	9	9
Plutonium throughput held in process plant residues		%	2	2	2	2	2	0.5
Number of batches in fuel cycle			2	6	6	6	6	6
Fuel pellet diameter		mm	6	5	5	5	5	6
Can thickness/fuel pellet diameter			0.075	0.075	0.075	0.075	0.075	0.080
Linear rating		W/mm	50	50	50	50	50	50
Mean mass rating		MW(th)/te heavy atoms	229	330	330	378	378	229
Maximum core burn-up		% heavy atoms	10	10	10	12.5	7.5	7.5
Fuel density		% theoretical	80	80	80	70	70	80
Core height		m	1.2	1.2	1.0	1.0	1.0	1.0
Axial breeder height		m	2x0.4	2x0.4	2x0.4	2x0.4	2x0.4	2x0.5
Radial breeder thickness		m	0.4	0.4	0.4	0.4	0.4	0.4
Core diameter		m	2.88	2.62	2.66	2.70	2.61	2.86
Total sodium area/total core area			0.372	0.446	0.410	0.417	0.402	0.384
Fuel feed enrichment		%Pu(E)	15.6	17.7	17.0	19.5	18.2	13.9
Inventory		kgPu(E)/GWe						
In pile at equilibrium			2940	2350	2230	2230	2080	2640
Out-of pile at 75% load factor			2334	1228	1184	1042	1628	1368
Total at 75% load factor			5274	3578	3414	3272	3708	4008
Plutonium flow		kgPu(E)/GWey						
Input to core			1921	2050	1936	1739	2735	2160
Production in core			823	545	558	491	515	676
Reduction* in core			-787	-798	-789	-797	-797	-775
Production in breeders			387	437	455	507	488	424
Reduction* in breeders			-40	-33	-34	-73	-28	-19
Total output			2094	2200	2126	1867	2913	2466
Net plutonium production		kgPu(E)/GWey						
Before reprocessing	Core		-174	-254	-231	-306	-282	-99
	Axial		130	139	176	179	196	203
	Radial		217	265	245	255	264	202
	Total		173	150	190	128	178	306
After reprocessing	Total		131	107	147	91	120	293
Equilibrium linear doubling time at 75% lf		y	53.4	44.8	30.9	47.9	41.2	18.2

*Reduction of Pu(E) includes fission and conversion of Pu to higher isotopes and 6) include changes in parameters which lead to an increase in breeding gain. The last column (6) also includes the effect of increasing the net plutonium production by reducing the quantity of plutonium lost to the fuel cycle and held in processing plant waste residues. It is to be noted that a nine month plutonium out-of-pile time and ½ per cent plutonium throughput retained in waste residues from fuel reprocessing and fabrication plants are consistent with the ultimate aim of current R&D programmes on the fast reactor fuel cycle.

It will be noted that changes to core parameters made by the designer can enforce other changes to maintain acceptable reactor operating conditions. For example, comparing columns 4 and 5 it is seen that decreasing core burn-up allows a reduction in the plutonium enrichment of the feed fuel required to sustain reactivity during the irradiation period. For a given mean mass rating a higher flux level must be maintained in the reactor with lower enrichment and hence a higher flux and greater power output will occur in the breeder regions, giving a greater plutonium production in both the radial and axial breeders. For a given reactor power output this reduces both the total mass of fuel and the plutonium inventory within the core. However, the reduced burn-up increases the frequency of refuelling and hence the throughput of fuel round the fuel cycle. Thus, the out-of-pile inventory is increased to such an extent that the total plutonium inventory is increased, resulting in a reduction of the fast reactor capacity available from a given supply of plutonium. The reduction in core enrichment at the lower burn-up increases the competitive absorption of neutrons in the uranium relative to that in plutonium. The amount of plutonium created during operation is therefore enhanced and the net plutonium loss is reduced. The overall result is seen, therefore, to be an increase in plutonium inventory and an overall increase in net plutonium production. The latter more than compensates for the former and together they produce a reduction in doubling time. Similar arguments can be applied to any changes in parameters listed above.

Summary

The data presented indicate how the net plutonium production in fast reactors can be varied by changing core and breeder parameters.

A small fissile inventory is achieved by employing a high mass rating which requires a high fissile enrichment. This results in a lower U-238 content and to a loss in core breeding gain, indeed most high rated LMFBRs within the practical range under consideration have negative internal (core) breeding gains. A negative breeding gain means that reactivity falls steadily with irradiation, so that the achievement of higher irradiation levels requires higher initial fissile enrichment thereby reducing further the core breeding gain. In these circumstances it is necessary to rely on fissile material created in the blankets outside the core to give an overall positive breeding gain and hence an overall net positive plutonium output.

Fuel processing outside the reactor is important also. A reduction in the time plutonium is held-up between discharge and re-loading results in a reduction in the total fissile inventory required for each unit. Reducing the amount of plutonium held up in waste residues increases the net production of plutonium. Both effects result in a decrease in doubling time. Both the out-of-pile time and the concentration of plutonium in residues will therefore be reduced to the minimum consistent with sound operating practice and economics.

Acknowledgement

Due acknowledgement is made to Mrs. J.M. Ball who carried out the calculations for the accompanying Table.

APPENDIX III

Value of plutonium and spent fuel

The purpose of this appendix is to derive an expression for the economic value of plutonium at a time when fast reactors have become established in the world.

Let B be the total cost of electricity produced from the established fast breeder fuel cycle as shown in Figure 9 and suppose in the first instance that the cost ignores the value of plutonium altogether. Suppose also that B is expressed in units of $ per year per kWe of installed capacity.

Let R be the total cost of electricity produced in the reprocessing cycle shown in Figure 5 with R also expressed in $ per year per kWe installed capacity and again assuming that the value of the plutonium produced by this reprocessing cycle is ignored.

As shown in Figure 1, the amount of plutonium produced by a PWR operating at a 100% load factor (L = 100) is 270 Ekgs or

$$2.7L \text{ Ekgs}$$

at load factor L.

Now let the value of this amount of plutonium be V and consider how these electricity costs are changed if plutonium acquires a market value. In the reprocessing mode no use is made of the plutonium. It is, therefore, available for trade and the cost of electricity produced in the reprocessing cycle is thereby reduced to a quantity of R' where

$$R' = R - V$$

and V is the value assigned to the plutonium produced. It follows that the value of the plutonium can be expressed as

$$\frac{V}{2.7L} \ \$/\text{Ekg}$$

However if V has a non-zero market value then the cost of electricity produced by the fast breeder must be increased to allow for the initial accumulation of plutonium which is necessary before the breeder can be launched. Since no plutonium is used during this period, this can be charged for simply in the form of an interest payment. Taking only this factor into account, we would then arrive at a new cost of electricity from the breeder, B', given by

$$B \longrightarrow B + tVi$$

where t is the accumulation time defined by Figure 17 so that tV is the value of the initial inventory of plutonium and tV × i the interest per year paid upon that additional capital cost. This last formula, however, is not quite correct because the fast breeder can also produce some excess plutonium and we must give it a credit for doing so. Because it can reproduce its inventory in the doubling time τ we arrive at the expression

$$B' = B + tVi - \frac{tV}{\tau}$$

which simplifies to

$$B' = B + tV(i - \frac{1}{\tau})$$

If we now imagine trade in plutonium taking place between the utility operating the reprocessing cycle and the utility operating the breeder cycle, then an equitable trading relationship would result in R' and B' being equal so that

$$R - V = B + tV(i - \frac{1}{\tau})$$

and

$$V = \frac{R - B}{(1 + t(i - \frac{1}{\tau}))}$$

In the text of the lecture, it was stressed that the product actually being traded is not likely to be plutonium at all but to be spent thermal reactor fuel. It is therefore appropriate to calculate the market value of spent thermal reactor fuel. Let this be D in the same units of $ per year per kWe installed capacity. Then D incorporates the value of the plutonium which we have just calculated and the value of the uranium recovered from the spent fuel off-set by the cost of reprocessing the fuel and vitrifying the fission product waste. We then get the formula

$$D = V + x(U - U_{CB})$$

where x is the fractional saving in uranium ore from operating the reprocessing cycle as distinct from operating the once-through cycle. According to the table given in Figure 7, x is therefore 23 per cent. U is the contribution made by uranium to the cost of electricity in the once-through cycle again expressed in units of $ per year per kWe installed capacity. The parameter U_{CB} represents the value of U at which the cost of electricity from the once-through and the reprocessing cycle become equal. U_{CB} is therefore proportional to the cost of reprocessing the spent fuel, again expressed in units of $ per year per kWe installed capacity. Clearly if U is less than the U_{CB} the price paid for spent thermal reactor fuel will be rather less than the price that would be paid directly for the plutonium it contains, whereas, if the price of uranium ore (U) has drifted above the value U_{CB} then the market value of the spent thermal fuel will be greater than the market value of the plutonium it contains. For simplicity I have omitted here the differential costs of enrichment between the once-through and the reprocessing cycles. This would affect the numbers but not the principle.

This analysis is valid only if the utility operating fast reactors remains "plutonium hungry". Since a fast breeder is self-sufficient in fuel, this cannot be true of a fast breeder utility operating a static total generating capacity. If the total capacity of the fast reactor utility grows only very slowly then it can be self-sufficient in plutonium. If the generating capacity at any one time is G, then the maximum self-sufficient rate at which G can grow is given by the formula

$$\frac{dG}{dt} = \frac{G}{\tau}$$

If the linear doubling time τ is fifty years then this corresponds to a 2 per cent growth per year. If the doubling time is thirty years, then this corresponds to about 3 per cent per year. If the growth rate in fast reactor capacity is higher than this, then the fast utility needs to buy in plutonium or spent fuel from elsewhere and this creates the context for a trade in spent fuel.

It may be noted finally where there may be a period during which an opportunity cost is associated with using plutonium in fast reactors rather than thermal reactors. This period will be brief however and the opportunity cost small. The value of thermal recycle over and above that of simply recycling uranium, V', may be defined as

$$V' = (y - x)(U - U_{RT})$$

where y is the fractional saving in uranium ore from operating thermal recycle in the place of the once-through cycle, and where U_{RT} is the uranium price at which the cost of electricity from the reprocessing cycle and thermal recycle become equal. As we have seen earlier (y − x) is small, amounting to some 16 per cent. While there is likely to be a brief period of positive (U − U_{RT}) for which V' > V, this will be a transitory phenomenon and is unlikely to be a significant factor in promoting a decision to invest in thermal recycle rather than in the use of fast reactors. □

Mr. **McCormack.** Before I ask you to proceed, I just want to say it is quite obvious what the advantages of not running for reelection are.

Go ahead, Manning.

[A biographical sketch of Mr. Muntzing follows:]

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June 3, 1980

L. MANNING MUNTZING

Born Harrisonburg, Virginia, June 24, 1934; admitted to the District of Columbia, Maryland and West Virginia Bars 1960. Preparatory education, University of North Carolina (A.B., 1956) Phi Beta Kappa; Woodrow Wilson School for Public and International Affairs, Princeton; Harvard Law School (LL.B., 1960). Counsel, Chesapeake and Potomac Telephone Company, 1960-71; Director of Regulation, U. S. Atomic Energy Commission, 1971-1975. Member, Editorial Advisory Board, Progress in Nuclear Energy, International Review Journal, 1976 - present. Member, Board of Trustees, National Presbyterian Church, 1977 - present. Member, the Bar Associations of the District of Columbia, State of Maryland, State of West Virginia, Federal Bar Association (Chairman: Atomic Energy Committee, 1975-1976; Council on Science, Technology and the Law Section, 1976-1979), and the American Bar Association. Member, American Nuclear Society (Board of Directors and Executive Committee, 1977 - present); ASTM (Member, Research and Technical Planning Committee 1976 - present/Chairman, 1978 - present). Editor of INTERNATIONAL INSTRUMENTS FOR NUCLEAR TECHNOLOGY TRANSFER.

STATEMENT OF L. MANNING MUNTZING, MEMBER, EXECUTIVE COMMITTEE, BOARD OF DIRECTORS, AMERICAN NUCLEAR SOCIETY

Mr. **Muntzing.** Mr. Chairman, I will submit my statement for the record and just talk briefly with the committee about some of the issues, principally the international institutional issues that the world now faces after the INFCE exercise.

It is rather ironical to me to note what has occurred. In the past the United States had a monopoly over nuclear technology and nuclear materials and during that period of time, during the 1950's and 1960's and early 1970's it perceived that its approach to nonproliferation could best be achieved by international cooperation and international consensus. Out of this view grew the Non-Proliferation Treaty, the International Atomic Energy Agency agreement and Limited Test Ban Treaties.

This I think was the right way to approach the problems of nonproliferation. Unfortunately and ironically, just at the time we lost our monopoly, the U.S. Government decided to proceed on a course of unilateralism rather than internationalism. As the result we have seen the actions of April, 1977, when the United States took unilateral action with regard to reprocessing and the breeder. We have seen the Nuclear Non-Proliferation Act of 1978. Only just recently with the INFCE exercise and other initiatives that are now coming forward may we possibly return to a more international approach which I believe is the one way in which we can bring the nations of the world to a consensus on nonproliferation.

With regard to INFCE there are a few things we might keep in mind. In the first place the U.S. Government felt that there would be some magical alternative fuel cycle which was going to solve all proliferation problems. That has not occurred, and we should firmly put that behind us. We should realize that the uranium plutonium fuel cycle is no more proliferation prone than any other fuel cycle and it is the one that we know. It is the one that we have worked with and it is the one we should pursue. I think INFCE has finally put that issue to rest and for that reason it is a good success.

In addition, the administration realizes that this being so, the question is no longer how do we live without plutonium but how do we contain it, and that I think is the more relevant question. It has taken some time for the administration to move to this but they, in fact, have recognized that there are nations that will reprocess, that will have recycle, that will have the breeder.

Whether the United States is going to be one of those nations, I do not know. But in any event, at last this country has realized that other nations will proceed on that particular course.

In addition, the U.S. approach has been one of self-denial and example. I think this misses the point. What we should be focusing on are issues such as secure fuel supplies and active participation of the United States in international nuclear commerce. What I am afraid of is that the United States, if we are not careful, is going to isolate itself from the international community. That we should not do. We should be there with our technology, with our ideas, with our creativeness so that we can bring to the international problems of using plutonium the kind of expertise that this Nation has provided to the world through the years.

If we walk away, it will be a great disservice to the world and it would not enhance nonproliferation. In fact, to walk away from it I think would not encourage the kind of strong nonproliferation efforts that can be made and should be made.

One of the important things, in addition to all the technical issues that can be discussed, as well as the institutional ones, is motivation. This is something the United States must keep constantly in mind in its diplomatic initiatives. The greater danger of proliferation of weaponry is for those countries that need energy or have some regional problem or do not have our nuclear umbrella, in other words, nations which are motivated for some reason in their own national interest to proceed with a weapons program.

The object of this administration and this Government's diplomatic initiatives should be to make sure that those motivations are removed and that the desire or feeling that there is a need for a weapons program is removed. How do we do that? Well, I think the United States in the first place should do more than just promise to be a reliable supplier. We should get into the thick of the various institutional concepts that are now under consideration and we should vigorously take part in the international and the regional and the multinational arrangements that are under consideration.

At this point I would like to review with the committee a half dozen institutional changes that could affect the world's nonproliferation issues and could affect the ability to control weapons proliferation throughout the world.

First, let's talk about fuel assurances. This is an extremely important matter to countries, and if they are afraid they cannot get enrichment services from the United States, what are they going to do? They are going to proceed to develop their own enrichment technology and we see examples of that in the world today. Being a reliable supplier of enriched uranium I think is a very strong position to be in. In order to control the problems of nonproliferation we need not only be in a position of supplying enriched fuel but also in a position of saying that nations who have good nonproliferation credentials will receive their fuel without a new license every year. I ask, "Why should not a country with good nonproliferation credentials receive a generic license for its enriched fuel for the lifetime of the reactor?" That would be an assurance of supply that I believe is needed.

Second, on the international scene the IAEA at its Board of Directors meeting in June of this year will take up the question of assured supplies of fuel and they will deal with such things as international nuclear fuel banks as well as the possibility of emergency banks as well as the idea of international consulting groups on the uranium market. These are all good initiatives, and I would hope that this administration would support strongly the efforts that will be initiated at the IAEA to develop fuel banks, emergency banks, and cooperative arrangements so that the nations of the world using nuclear fuel can be assured that they can get the fuel for the reactors to supply the power they need and are not subject to the unilateral determinations of an individual country.

Let me turn now to something that is called IPS which stands for international plutonium storage. This is a concept that was initiated several years ago primarily by the United Kingdom and the Netherlands. It has been proceeding under the auspices of the IAEA. There have been meetings as recently as this past month on the subject in an attempt to try to structure a concept for international plutonium storage. There are a lot of problems that must be worked out. One of them is colocation. And I know, Mr. Chairman, you have been quite interested in this subject, the multilateral regional fuel cycle centers. Certainly, an international plutonium storage facility should be considered in the context of both reprocessing facilities and fuel fabrication facilities, because an IPS could very logically be on either the back end of reprocessing or the front end of fuel fabrication.

There is no reason why the IPS's which may finally be put into place could not be colocated with the various reprocessing and fuel fabrication facilities. This would be a good step forward with regard to nonproliferation problems. It tends to address the question that was raised earlier this morning; namely, how long would it take for a country to produce a weapon.

Well, if in fact the spent fuel and the excess plutonium are moved into a multinational fuel cycle center, I think that the possibility of unilateral action by one country is greatly reduced. I think that the IPS concept is a good one In addition to the problems of colocation there are release problems. What are the criteria for release? There are also the problems of the United States' prior consent rights which we hold over a great many nations. We must be flexible. If we are going to get nations to put their excess plutonium into an IPS, we have to be flexible enough to give up some of our existing bilateral prior consent rights and let the IPS make those determinations, rather than insisting on doing it all ourselves.

Mr. McCormack. May I ask a question at this point? When we talk about international plutonium storage isn't it most practical to talk about it in terms of new fuel elements and an international fuel bank? After all, if we have coprocessing and maybe postirradiation or postspiking of fuel so that it requires shielding, or even if it doesn't have that particular precaution, if we have the plutonium as a mixed oxide fuel designed for specific plants and then an international bank, doesn't this constitute the optimum form of plutonium storage?

Mr. Muntzing. Mr. Chairman, if we had a very firm program of recycle and breeders throughout the world and we knew exactly what we needed and when, I would agree with you completely.

The problem, I think, is that we just do not have that in place at this time, certainly not in this country or in other countries. What I guess is generally conceived is that there will be a period of time, maybe a long period of time, in which excess separated plutonium will be available and the question is, where should it be stored and how should it be maintained?

You could move directly from reprocessing into mixed oxide fuels. You might prefer to keep it in the separated form, however, until you make up your mind what are you going to do. Are you going to recycle it and for which kind of reactors or are you going to make it into breeder fuel?

You might have an additional step there that you might not want to take, but that is an alternative to having it spiked so that it is inherently not available to people who might want to divert it to some other purpose.

Mr. McCormack. In that respect, what is your perspective with respect to the demand for plutonium between breeders and conventional plants? Can we project what the demand will be for each technology reasonably, or will we be able to at a later time and is it likely that the demand for plutonium for breeders will completely dominate the market and not allow any for conventional plants?

Mr. Muntzing. I think it can be predicted. It is a little uncertain at this time. We have enough trouble trying to predict energy demands, and what the relevant supply should be. But it is quite clear that uranium is an exhaustible resource. We argue as to whether we are going to run out of resources in the year 2000 or the year 2020—people will disagree on the dates, but it is exhaustible. The value I suppose principally of recycle has been the feeling that it gave fabricators and utilities experience with handling plutonium. And if there were safeguards issues, there was time to deal with those in the context of mixed oxide fuels. And it was viewed I think as a transition through to the breeder. Now I hear the administration saying we don't need recycle because it is not economical and it improves utilization of uranium only in a marginal way, 10 or 15 percent; therefore, it is unnecessary and ultimately the real need and use will be for the breeder. I would agree that that is right, that the real use should be in the breeder program as opposed to recycle.

I tend to think though, drawing on my prior experience as a regulator, that the industry and the public is well served by stepping through the nuclear options and gaining experience one day at a time rather than trying to leapfrog into bigger things overnight. It is not from an economic point of view but more from an operational health and safety point of view that I think it would be useful to gain experience in recycle and then move into the breeder.

In time the projections can be made as to how much is needed for which purpose. I would not overemphasize the need for plutonium in the recycle area as opposed to using it in the breeder.

Mr. McCormack. Thank you.

Mr. Muntzing. Let me continue with a few additional examples of international institutional concepts that are underway. The next one I would like to mention is the international spent fuel study, again organized by the IAEA. This study is considering various possible spent fuel storage facilities throughout the world. In addition, the United States and Japanese Governments on a bilateral basis are looking at the Pacific Basin area and some of the studies there may be useful to the IAEA as it considers international spent fuel storage facilities.

Now what bothers me is that I think the U.S. administration is putting its primary emphasis on this study. It is primarily supporting the spent fuels study and I think that while it is important to do so that it is equally important if not more important to look at the international plutonium storage and to look at the assurance of supply issues and that those two should carry as much emphasis and support from this administration as the spent fuel storage study.

Next let me mention that back in 1968 President Johnson offered to place various licensed facilities in the United States, under IAEA safeguards. To implement this agreement it was signed with the IAEA and submitted to the Congress in February 1978. It is still pending in the Senate. It has not yet been ratified. Most recently I have heard that it should move forward. In fact, this would be a reasonably important institutional step for the United States to take. We have made a commitment to it. We have said to the world we will do it. We have not yet done it. It is beginning to create a problem as to the importation of uranium from Canada and from Australia eventually, because they are insisting on full safeguards with the United States. If we intend to continue to import fuel for enrichment purposes from Canada and eventually from Australia, it is important to go forward with the ratification of the so-called "voluntary offer" to place IAEA safeguards on licensed facilities within the United States.

In addition, it is important to keep in mind that that particular offer may well help to blunt some of the criticism that the United States may hear at the review of the Non-Proliferation Treaty which is coming up for review in August of this year in Geneva. Every 5 years there is such a review and the nations of the world who subscribe to the Non-Proliferation Treaty—there are now 113—will be critical of the United States in certain respects, article VI calls for vertical reduction of armaments and article IV encourages the exchange of technology. One of the things the United States, when it goes into that conference, could and should have is the ratification of the voluntary offer as we have promised for many years.

Let me mention one last international institutional initiative which is an initiative of the United States and that is the new Convention on the Physical Protection of Nuclear Materials. This was opened for signature in March 1980. The United States has indicated that it will ratify. It is intended to provide physical protection to nuclear materials in transit as well as within countries and I think it is a good step forward in trying to have an international commitment and should help in physical protection of nuclear materials.

Let me say this in closing: The initiatives I have described are primarily initiatives concerning assured supply of fuel, international plutonium storage and international spent fuel. These initiatives are not going to be resolved overnight. It will take some time. It will take some good diplomatic efforts. It will take a lot of discussions. Out of it though I think we will see the development of an international consensus and the time taken will be well spent. I am not sure that is all of the initiatives we need, but it is a rather full agenda. I suppose that one of the outgrowths of INFCE is the fact that we do see these institutional efforts being made and if and when they are put in place, we then can be assured that the proliferation risks which we are all concerned about are being minimized and controlled within the institutions that are possible to adopt.

Thank you, Mr. Chairman.

[The prepared statement and additional Q's and A's asked of Mr. Muntzing follow:]

Statement of

L. Manning Muntzing

Doub and Muntzing, Chartered

Before the

Subcommittee on Energy Research and Production

Committee on Science and Technology

House of Representatives

June 5, 1980

Mr. Chairman, I am pleased to appear before your Subcommittee today to discuss various international institutional aspects of nuclear commerce relevant to your consideration of new directions for nuclear research, development and demonstration post-INFCE. I do so in my personal capacity although I have served as the coordinator for the American Nuclear Society on INFCE matters.

With the conclusion of INFCE the record is now clear, as has long been well known to most technically qualified observers, that the uranium-plutonium fuel cycle is optimal from an energy efficient point of view, and does not suffer a significant proliferation disadvantage by comparison with other fuel cycles. None of the so-called "alternative" nuclear fuel cycles is completely free from some residual proliferation risk, yet none of them possess any overwhelmingly non-proliferation significant advantage. Consequently, particularly for the United States and other industrialized nations in Europe and Japan, there seems to be virtually no reason why the uranium-plutonium fuel cycle should not be pursued with appropriately improved safeguards and international institutional arrangements to minimize the proliferation risk that may exist.

Indeed, I would point out, that the United States, apparently in anticipation of the results of INFCE, has for a number of months been shifting from its attempt to live without plutonium to an effort to contain it. The Administration has come to characterize its policy regarding the breeder and reprocessing, at least for industralized countries with significant power grids, as a short term pause, rather than a lasting arrangement; the pause to exist only until the international community can achieve an effective framework governing the use of plutonium. Such indications of movement away from the Administration's April 1977 position of indefinite deferral acknowledge that certain countries will proceed with their reprocessing and breeder programs and that the United States is willing to find their use acceptable under certain circumstances. The United States, in my view, should now come increasingly to emphasize well-structured institutional arrangements and ever better safeguards as the best course to follow. The so-called non-proliferation advantages of alternative fuel cycles should be put firmly behind us.

The last few years clearly reveal that the stated official United States policy has been based too much on concepts of self-denial and example and far too little on secure fuel supplies and the active participation of the United States in international nuclear commerce as the only real way of achieving lasting non-proliferation influence in the world. The message of INFCE should not be missed, the time for a change of direction is upon us.

Further, U.S. policy has focused too much on impacting developed nations rather than industrialized smaller countries in the third world in which states the greater future expansion of nuclear energy probably will occur. The risk of nuclear weapons proliferation, for example, cannot be reduced to zero since the knowledge, technical capacity and basic materials for making nuclear explosives are now widespread. The real problem is how to avoid proliferation by insuring adequate energy and not how to insure problems by denial of energy. No amount of international policing consistent with present concepts of national sovereignty -- let alone the accute sensivity of many smaller nations today -- can with an absolute guarantee prevent a nation from developing explosives. I hope that INFCE has demonstrated that the United States in the future must recognize that other nations do not respond to foreign unilateral edicts lightly. While nations will give up some sovereignty for larger concerns, they generally will seek to retain maximum authority over their domestic decision-making, and will not consider another nation's decisions on economics and industrial efficacy to be binding on them.

The United States must now recognize that suppliers as well as recipients have obligations. These obligations cannot be fulfilled by promises to be a reliable supplier. INFCE has shown that the United States should turn away from its unilateralism and vigorously enter into international, regional and multinational arrangements that give promise of revitalizing international nuclear commerce. We must turn from our wish that the uranium-plutonium fuel cycle would just go away and recognize that the only realistic course open to us is to take proper steps to utilize its benefits and control its dangers.

Perhaps we have now come full cycle to the situation that pertained when the United States still had the world's nuclear monopoly. That was a time, you will recall, of vigorous American efforts to internationalize controls over civil nuclear energy uses. Only as our monopoly began to disappear did we start our self-defeating efforts based upon unilateral actions. We have been called up short. We must move into a new era of sound international cooperation and renewed diplomatic initiatives. Collaboration not dictation must again become the watch word of our nuclear future.

I now turn to a consideration of several matters pending on the United States' international, multilateral and bilateral agenda which if given proper and timely handling can further the realization of such sound cooperation.

First, in order to improve fuel assurances and to speed the export licensing process, the United States should expand its tentative efforts to increase the issuance of generic licensing of certain items and licensing for multiple reactor reloads of low-enriched fuel for countries with good non-proliferation credentials. Even further, we should also support long-term fuel supply assurances for foreign reactors, either for the lifetime of reactors or a significant period, say, ten years or more.

Second, the concept of an international nuclear fuel bank which would serve as supplier-of-last-resort in case of a temporary breakdown in the supply of nuclear fuel should be further developed. The bank's customers would be developing countries primarily, together with a few small industrialized countries, which agree to various non-proliferation conditions.

Such a nuclear fuel bank, discussed at INFCE in Working Group 3 could be established by an international agreement such as the one now being discussed in the Executive Branch. Further, proposals for back-up arrangements among customers and producers of nuclear fuel, to meet emergency needs resulting from supply disruption, and an international consultative group on the uranium market, should be pursued. The latter would provide a means for the exchange of information among key supplier and consumer governments concerning exploration levels, market activities, and supply prospects.

Third, during INFCE a rather remarkable political consensus has emerged among the majority of the participants favoring a scheme for international plutonium storage (IPS). This should be vigorously pursued. While the storage of plutonium under international control was foreseen by the drafters of the IAEA Statute and was incorporated into Article XII, the provisions of Article XII have never been implemented. But now, following a series of meetings, an IAEA Experts Group has before it a first draft of an agreement to establish a storage scheme within the framework of the IAEA. The draft covers the nature and location of stores, release procedures and criteria, conditions of use, and an overall institutional framework. The suggested arrangement contemplates a multi-lateral agreement establishing IPS which would be approved by IAEA's Board of Governors. Following Board approval the agreement would be open for acceptance by all states. Although it has not yet been worked out, it has been suggested that a subsidiary body, referred to as a commission, should assist the IAEA Board of Governors in the implementation of the proposed IPS scheme, while day-to-day operations would be carried out by IAEA personnel.

Of particular concern to the United States in any storage program will be the terms for storage, particularly the conditions for release of stored plutonium for use by the depositing nations. It seems essential that a regularized and certain arrangement for the deposit and withdrawal of plutonium be agreed upon and specified uses be placed beyond the unilateral control of any one country to achieve the IPSs certainty of supply and related non-proliferation goals. In addition, the relationship of IPS to other fuel cycle facilities must be considered, particularly reprocessing and fuel fabrication plants. This concept of co-location was expressly recognized by INFCE as a contributor to reduced proliferation risk and should be pursued, recognizing that these facilities will entail complex negotiations and arrangements, including the restructuring of existing reprocessing plants.

Fourth, the United States should continue to take an active role in the International Spent Fuel Management (ISFM) study organized by the IAEA. The ISFM study is considering the technical, economic, institutional, legal, and procedural aspects of the storage of spent power reactor fuel. ISFM builds on the results achieved in INFCE's Working Group 6, that evaluated economic and technical aspects of various approaches to spent fuel storage.

Complementary to this study are the bilateral arrangements between the United States and the Japanese governments to study the concept of an interim storage facility for spent nuclear fuel in the Pacific Basin area. A communique was issued jointly by the United States and Japan on September 22, 1979, expressing the intention of both governments to proceed with the necessary steps to working out an appropriate arrangement for conducting a joint feasibility study.

The United States has made preliminary investigations on the possibility of establishing a Pacific Basin storage facility. Technological and economic evaluations have been completed, as well as preliminary and environmental checks of Midway, Palmyra, and Wake Islands as possible sites. These study results may also contribute to the desirability of developing similar storage centers elsewhere operated on either a worldwide or regional basis.

Fifth, in 1968 the United States voluntarily offered to place its civil nuclear facilities under IAEA safeguards as an inducement for other countries to ratify the Non-Proliferation Treaty. On February 2, 1978, President Carter sent an agreement with the IAEA for that purpose to the Senate for approval. To date, no action has been taken by the Senate. U.S. failure to carry out this offer will give states which now accept IAEA inspection reason to complain and perhaps to reconsider their commitments.

Also, unless the agreement is ratified, Canada and Australia are unlikely to export uranium to the United States because they now require full-scope safeguards as a condition for their exports, and have agreed that the United States safeguards agreement with IAEA would satisfy their requirements. Since this uranium is of considerable importance to both United States and foreign utilities as enrichment feedstock, early ratification of the voluntary offer agreement appears highly desirable.

Sixth, on October 26, 1979, the Convention on the Physical Protection of Nuclear Materials was completed in Vienna. The Convention, a United States initiative, establishes a regime of international cooperation to improve the physical protection of nuclear materials used for peaceful purposes. It requires states which are parties not to export or import or authorize the export or import of nuclear material used for peaceful purposes, unless assurances have been received that such material will be protected during international nuclear transport at established levels. Each party is obligated to take appropriate steps to insure that nuclear material in international transport is protected when such material is within its territory, or on board a ship or aircraft under its jurisdiction engaged in transport to or from that state. The Convention also provides a framework for international cooperation in the recovery and protection of stolen material and defines certain serious offenses involving nuclear material which parties are to make punishable and for which offenders will be subject to a system of prosecution or extradition.

The Convention was open for signature on March 3, 1980, simultaneously at the IAEA in Vienna and the United Nations in New York. Its ratification by the United States, and adoption by other international nuclear trading countries, will contribute yet another strong element in the furtherance of the world's peaceful use of the atom.

Finally, in August of this year the second Non-Proliferation Treaty Review Conference will be held in Geneva. The outcome of this conference can affect international support for the Treaty and the committments it requires. Because the United States is likely to be criticized by many of the participating countries for failure to make significant arms control progress, especially in SALT and the conclusion of a comprehensive test ban agreement, should the voluntary safeguards offer agreement not have been approved by August it can be expected that criticism on that count will be registered too. Further, many countries, particularly those of the third world, are likely to argue that restrictions on exports of sensitive nuclear technologies and items remain an unreasonable discrimination by the nuclear supplier states.

Although the possibility of extended discussion of INFCE-related questions at the Review Conference seems limited, particularly in view of the call by many of the developing countries participating in INFCE for a 1983 United Nations Non-Proliferation Conference, careful handling of the NPT Review Conference by the United States will nevertheless be very important to a strong post-INFCE image.

The completion of all of these international institutional initiatives will not occur rapidly or without considerable effort. This is particularly so where the philosophical approach is that of collaboration, rather than dictation by a few countries. The extra time required to reach agreement will be well spent as nations participate and thereby become a part of the ultimate consensus. As this process proceeds, it may become apparent that further initiatives will help to minimize proliferation risk. However, at this time it is my opinion that the list of initiatives is a full agenda that, when completed, should result in international institutional arrangements that will permit nations to enjoy the benefits of nuclear power while controlling proliferation problems.

Mr. Chairman, this completes my brief discussion of some of the post-INFCE international institutional matters of importance. I would be pleased to answer any questions the Subcommittee may have.

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
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WASHINGTON, D.C. [illegible]

June 11, 1980

L. Manning Muntzing, Esquire
Doub and Muntzing, Chartered
1875 Eye Street, N.W.
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Dear Mr. Muntzing:

Thank you once again for appearing before the Subcommittee on Energy Research and Production during our June 5 hearing on the International Nuclear Fuel Cycle Evaluation study, and the implications for future nuclear energy research and development. We found your testimony particularly insightful and useful, and we sincerely appreciate you sharing your expertise with us.

During the hearing, we indicated that the Subcommittee might request some additional information in the form of further questions. Having reviewed the testimony received at the hearing, we find that additional information would be very helpful. Accordingly, we would appreciate your providing, for the record, responses to the enclosed questions.

Your prompt reply would be most appreciated. Thank you for your cooperation on this matter.

Sincerely,

MIKE McCORMACK, Chairman
Subcommittee on Energy
Research and Production

MM/Cwn

Enclosure

QUESTIONS FOR
L. Manning Muntzing
following
INFCE HEARINGS
June 5, 1980

1. On what basis can the U.S. defend the practice of placing new non-proliferation conditions on existing nuclear fuel supply conditions? Has this practice helped or hindered achievement of our non-proliferation objectives?

2. In February, Walter Marshall of the UK Atomic Energy Authority, proposed that nuclear supplier nations buy up spent fuel from developing countries as a commercial operation, reprocess the fuel to recover plutonium which they would use, and pay the seller countries enough for them to buy enriched uranium to continue fueling of their reactors.

   What advantages would a commercial scheme offer over a purely governmental scheme?

3. What institutional arrangements and programs could be implemented to achieve real non-proliferation benefits and yet maintain nuclear power as a viable and important contributor to the energy needs of the U.S. and abroad?

4. To what extent are our export controls really affecting U.S. nuclear exports and technical assistance abroad?

5. What is the estimated financial loss to U.S. industry both domestically and in foreign trade of the current U.S. nuclear non-proliferation policy?

6. What changes, if any, have you seen in the perception of the linkage between nuclear power and proliferation as a result of INFCE?

7. To what extent would you agree that proliferation issues are likely to replace nuclear safety issues as TMI recedes into history?

8. What do you see as the effects of proliferation issues upon the future of nuclear power in the United States and abroad?

9. What is your opinion and that of the nuclear industry of the ideas of international spent fuel storage and international plutonium storage? How important are these for proliferation prevention?

10. How important are nuclear exports for the U.S. nuclear industry?

11. How do you view the proliferation resistance (risks) of light water reactors with permanent fuel storage in comparison to breeders?

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June 27, 1980

Honorable Mike McCormack, Chairman
Subcommittee on Energy Research and
  Production
Committee on Science and Technology
U.S. House of Representatives
Suite 2321, Rayburn House Office
  Building
Washington, D.C. 20515

Dear Congressman McCormack:

Thank you for your letter of June 11, 1980 which enclosed certain questions concerning the INFCE related matters discussed before your committee on June 4-5, 1980.

Enclosed you will find my answers to those questions. I am pleased to have appeared before your committee and appreciate this opportunity to expand those remarks.

Yours sincerely,

L. Manning Muntzing

L. Manning Muntzing

LMM/dgb

Enclosure

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MEMORANDUM

June 27, 1980

To: Honorable Mike McCormack, Chairman,
Subcommittee on Energy Research and Production

From: L. Manning Muntzing

Subject: Answers to Questions Submitted by the Subcommittee on Energy Research and Production following the June 5, 1980 INFCE hearing

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1. On what basis can the United States defend the practice of placing new non-proliferation conditions on existing nuclear fuel supply conditions? Has this practice helped or hindered achievement of our non-proliferation objectives?

The existing nuclear fuel supply arrangements between the United States and other countries is governed by three legal instruments, namely:

(1) a government-to-government agreement for cooperation;

(2) contracts for the supply of certain services, such as enrichment services; and

(3) export licenses issued by the Nuclear Regulatory Commission.

Shortly after President Carter's announcement in April 1977 concerning his policy on non-proliferation, there seemed to be an Administration view that the existing agreements for cooperation could simply be abrogated, and new conditions could be added unilaterally by the United States. However, it was finally conceded by the Administration that the existing agreements could not be unilaterally changed, and the Nuclear Non-Proliferation Act of 1978 (NNPA) specifically provided that existing agreements for cooperation were not terminated by the new legislation. NNPA §405(a), 42 U.S.C. 2153d. However, the legislation did call for renegotiation of the agreements for cooperation to add certain new requirements. Whether all nations will agree to all such changes is unknown. It is to be expected that some nations will decide to rely on their existing agreement for cooperation unchanged. So long as a country refuses to change its agreement for cooperation, there is no basis for unilaterally adding conditions to the agreement for cooperation.

Contracts for fuel supplies differ from one supplier to another. However, most contracts normally contain a provision that the supplies are subject to domestic laws and regulations. A question thus arises whether these provisions contemplate only those laws in existence at the time the contracts were signed or all laws enacted thereafter that would affect such contracts.

The export of special nuclear material, such as enriched uranium, requires an export license from the Nuclear Regulatory Commission. Because these are handled on a case-by-case basis for each export, as opposed to a long-term export authorization, the opportunity exists for the Nuclear Regulatory Commission to add conditions of its own or as required by the Congress. This is one of the principal sources of uncertainty in the export arena and is a major method by which new non-proliferation conditions can be placed on commitments to supply nuclear fuel that take place over a period of time. Certainly, there would be neither neither authority nor ability to enforce an amendment to an export license that has been issued for an export that has occurred. But, continuing exports, with a new license required for each one, present this opportunity.

The above question also asks whether the practice of placing new non-proliferation conditions has helped or hindered non-proliferation objectives. It could be argued that a tough stance by the United States taking a unilateral position was needed in order to get the attention of the world with regard to proliferation risks. The result, though, has been to alert the world not only to non-proliferation risks, but also to the risk of interruption of fuel supplies. The reaction, not surprisingly, has been for many countries to support various non-proliferation proposals, but at the same time to move to insure themselves of adequate supplies of fuel. This means that some countries that would not have otherwise acted are now or will undertake programs to provide their own fuel sources, including enrichment capability, and to maximize their fuel utilization through recycle which requires reprocessing. The unilateral actions taken by the United States and its ability to continue to take such actions create a lack of confidence that leads other nations to take steps which increase, rather than decrease, their proliferation abilities. At the same time the United States' declining position in international nuclear commerce, also stemming largely from these unilateral actions, made it even less able to influence decisions by other nations that effect world proliferation potential.

2. In February, Walter Marshall of the United Kingdom Atomic Energy Authority proposed that nuclear supplier nations buy up spent fuel from developing countries as a commercial operation, reprocess the fuel to recover plutonium which they would use, and pay the seller countries enough for them to buy enriched uranium to continue fueling of their reactors.

   What advantages would a commercial scheme offer over a purely governmental scheme?

The program proposed by Walter Marshall is one that will be so significantly affected by governmental policy that it is unlikely that private interests would feel the risk associated with the scheme to be acceptable. At the very least, certain government guarantees and commitments would be necessary.

The obvious advantage of such a commercial program is the general reliability of commercial transactions that are motivated by meeting the commitments made and supplying the services agreed to. If, in fact, the entity fails to meet its commitments and provide its services, it will not continue to exist. On the other hand, a government operation, not needing to make a profit or meet a commercial obligation, is more apt to let government policy decide the critical questions. This makes the assurances more uncertain.

3. What institutional arrangements and programs could be implemented to achieve real non-proliferation benefits and yet maintain nuclear power as a viable and important contributor to the energy needs of the United States and abroad?

The principal institutional arrangements and programs that could achieve real non-proliferation benefits and maintain nuclear power as a viable energy contributor include the following:

(1) international plutonium storage;

(2) international spent fuel storage;

(3) international fuel bank and emergency supply center;

(4) continued adherence to the Non-Proliferation Treaty and more signatories to it;

(5) enhancement of the IAEA's safeguard capabilities, as well as its technical assistance programs;

(6) adoption by the nuclear nations of the Convention on Physical Protection; and

(7) adoption by the United States Senate of the IAEA Agreement to Implement the "Voluntary Offer" of IAEA safeguards on United-States-licensed facilities.

All of the above activities are under way to one degree or another. Their implementation would constitute a reasonable balance between minimizing proliferation risk and encouraging nuclear development.

4. To what extent are our export controls really affecting United States nuclear exports and techncial assistance abroad?

The export controls required under the Nuclear Non-Proliferation Act of 1978 have had a dampening affect upon United States nuclear exports. A report prepared by the Westinghouse Electric Corporation in April 1980 contains the following statement:

> "Loss of nuclear export orders result in a declining market share. Through 1974 the United States had received about 70 percent of the export awards of nuclear power plants in the world. During the next five year period (1975 through 1979), U. S. suppliers achieved less than 50 percent of export awards."

5. What is the estimated financial loss to United States industry, both domestically and in foreign trade, of the current United States nuclear non-proliferation policy?

The Westinghouse study referred to above estimated that over $9 billion worth of export trade has been lost during the last five years. In addition, the report made the following statement:

> "Market share loss affects employment opportunities. The loss of one export order means the loss of up to 60,000 man-years of employment for U. S. workers. This loss also translates into an erosion of technical leadership.
>
> "Market share loss also affects the balance of payments. The export value of one nuclear power plant project can exceed one half billion dollars. During the next ten years the potential market could easily exceed several billion dollars annually. Nuclear power plants and related fuel cycle services are probably the biggest single ticket item which the United States

> has in its export portfolio. Revenues from nuclear sales abroad can play a major role in our ability to compensate for the continually rising costs of oil imports."

6. What changes, if any, have you seen in the perception of the linkage between nuclear power and proliferation as a result of INFCE?

Nuclear power has always been, and is today, an undesirable route to weapons proliferation. This fact was confirmed by INFCE because all nuclear weapons nations became such as a result of programs and efforts that did not utilize their civil nuclear power program. Even India's 1974 nuclear explosion resulted from its research reactor and not its power program. In addition, experts in this field acknowledge that the most difficult, expensive, inconvient route to weapons proliferation, as compared with other methods, is the nuclear power route. It should be noted, however, that people knowledgeable about the production of electricity through nuclear power have a training and background that could be of some assistance in producing weapons if their experience were diverted to such a program. In addition, if spent fuel were permitted to be left unaccounted for, the potential for its reprocessing and use for weapons would exist.

7. To what extent would you agree that proliferation issues are likely to replace nuclear safety issues as TMI recedes into history?

Nuclear safety issues are in large part technical so that difficulties can be analyzed and corrected. To an astonishing degree, the industry and the regulators have responded in a thorough and comprehensive manner to the Three Mile Island safety issues. It is now a matter of public perception as to whether or not the safety issues recede or remain public concerns. In addition, with the significant number of nuclear power plants operating in the United States and throughout the world, we should expect the unexpected, which can keep the safety issue as a significant question concerning nuclear power through the years. Unless something unexpected occurs, the technical solutions should result in safety issues receding from public consciousness.

On the other hand, the issue of proliferation is not so much technical as political. Because of this, the process of developing consensus among nations and moving to new concepts is a time-consuming matter. It is unlikely that the non-proliferation issue will be quickly settled, and therefore, it will likely be part of the nuclear debate for most of the 1980's.

8. What do you see as the effects of proliferation issues upon the future of nuclear power in the United States and abroad?

The proliferation issue could well mean that some of the developing countries that had expected to use nuclear power as a source of electricity may see their expectations delayed, or even cancelled. This, of course, affects the United States' domestic program in that the anticipated commercial activities by United States concerns will be delayed or cancelled. Further, the

President's April 1977 non-proliferation policy has indirectly impacted upon the vitality of the domestic nuclear industry.

The proliferation initiatives that are under way should, however, serve as a means to minimize the perceived risk. When this is finally achieved, some of the delays that have occurred in the interim may then be stopped, and the expected nuclear expansion will be able to proceed.

9. What is your opinion and that of the nuclear industry of the ideas of international spent fuel storage and international plutonium storage? How important are these for proliferation prevention?

In the minds of some people, international spent fuel storage and international plutonium storage are incompatible. This, of course, turns on one's perception as to whether there will be breeder reactors or light-water reactor recycle, which requires reprocessing. An assumption that this will not occur makes plutonium storage unnecessary. It is my opinion that both concepts are useful because of the uncertainty as to when breeders, or even recycle, may be needed or available and therefor some spent fuel storage capacity is appropriate. This also permits removal of the spent fuel from many different locations to several highly controlled areas. In addition, some spent fuel has already been, and will continue to be, reprocessed, and the excess plutonium should also be carefully contained. Therefore, each concept has its place and is important to proliferation prevention in that each one removes to controlled areas the principal materials that provide a potential for weapons proliferation.

10. How important are nuclear exports for the United States nuclear industry?

Nuclear exports are indeed important for the nuclear industry for several reasons. The first, of course, is the commercial aspect that permits utilization of United States technology, particularly at a time when United States domestic requirements are not as strong as they have been. In addition, the opportunity for United States industry to operate in other countries, taking into account their local conditions and needs, is also of value to United States industry.

Another important consideration for a strong role of United States industry in nuclear matters through the world is the ability it gives the United States to have a significant impact on many issues, especially safety and non-proliferation questions. Certainly, those who are participating in this process commercially will be in a position to influence new directions that may be desirable.

11. How do you view the proliferation resistance (risks) of light-water reactors with permanent fuel storage in comparison with breeders?

In certain ways, breeder reactors are more proliferation resistant than are light-water reactors with permanent fuel storage. This is due to the fact that breeder reactors are burning plutonium, which is a proliferation risk, as a fuel. Light-water reactors with permanent fuel storage produce a situation where, over time, the spent fuel becomes less proliferation resistant due to its lessening radioactivity. The decreased radioactivity makes the spent fuel a more attractive diversion target.

The fuel cycles of the light-water reactor and the breeder reactor must be compared, and certainly, the enrichment process for the light-water reactors has a comparable proliferation risk with that of reprocessing and fuel fabrication for breeders. There are differences between the two, but in reality, both fuel cycles have a certain proliferation risk. In each case, however, the risk can be reduced through effective control.

Mr. McCormack. Thank you very much, Mr. Muntzing.

I have one specific question. The international conference to review NPT this year, that will come when?

Mr. Muntzing. In August in Geneva. It is August 11, I believe, through September 5.

Mr. McCormack. Do you anticipate that we will encounter criticism of the U.S. position as to the U.S. Nuclear Export Act as relates to article 4 of the NPT?

Mr. Muntzing. Yes, Mr. Chairman, I think that is quite possible. The NPT and the IAEA were based upon a feeling that the nuclear nations of the world must cooperate if in fact weapons proliferation is to be avoided. The United States decided that it neither had enough faith in the IAEA nor the NPT so it adopted the administration's policies of April 1977 which were followed by the Non-Proliferation Act of 1978.

Both of those are based on a distrust of the commitments that nations gave under NPT and give as members of the IAEA. I would suspect that the countries, led by Yugoslavia and others, will be rather critical of the solemn commitments that they have made and the distrust they have received in return.

Mr. McCormack. How do you expect that criticism to evolve? How will it end up? What will be the result?

Mr. Muntzing. The worst that could happen will be for nations which are perturbed, frustrated, and unhappy to withdraw from the NPT. That would be the worst. I think that would be extreme. I do not expect it. But I think that possibly what this may lead to is a United Nations Conference on the peaceful uses of nuclear power in about 1983. And through that conference at that time it may be that these frustrations, which are not resolved this year and which may or may not be resolved in the ensuing years as the IPS and spent fuel and the assured supply of fuel concepts go forward, will be aired at that time.

What would come out of that I do not know. But I think that many of the nations of the world, particularly some of the Third World or smaller industrialized nations of the world are not prepared to be dictated to and told what they can and cannot do and what type of fuel cycles they can and cannot have.

If we are not careful we will see a revolt and a reaction to the highhanded unilateral approaches we have taken. And we, I think, must be very careful or we will have lost a great deal more than we gain.

Mr. McCormack. We hear a great deal about this pejorative term plutonium economy. I had it marked as one of my questions yesterday which I did not ask Ambassador Smith. I very much agree with the comments by Dr. Starr that this is a red herring, but I am curious to know. Much of your testimony this morning is directed toward international treaties and programs that have to do with the control of spent fuel on a nonproliferation basis but it seems to totally ignore the uranium-235, for instance, which simply requires isotopic separation for which we now have a half dozen or so technologies, some of which are fairly available if not simple. At least they are easily available around the world. Is there some rationale for paying so much attention to plutonium and apparently ignoring uranium-235?

Mr. Muntzing. I think we all recognize that proliferation risks arise from both sides of the equation so to speak, both the enrichment side and the reprocessing plutonium side. The plutonium has received greater emphasis, I think that is fair to say.

Mr. McCormack. I think this was legitimate when the only technology for separation was gaseous diffusion. I think at that point a greater concern with plutonium was certainly legitimate. However, I think we are failing to recognize that that situation no longer prevails, and indeed it would be easier to get uranium-235 in the international community than it would be plutonium, if for no other reason than you can carry it around in your pocket.

Mr. Muntzing. We have seen examples around the world of people feeling that not having some weapons-grade material to reprocess, they will go forward with an enrichment program.

The thing about the enrichment program is to remove the incentives for people feeling that they must have their own domestic enrichment capability. Now, if in fact, people are concerned that they have an LWR which is going to take enriched uranium and they are not quite so sure that 5, 10, or 20 years from now they will have the enriched uranium, I think that drives them to producing domestically their own enrichment capabilities.

And when they do that you have a proliferation risk which is as big or as significant as having separated plutonium. That is the reason why I think the efforts are important on the assured supply of fuel, those efforts which include international fuel banks, international emergency facilities containing enriched uranium and possibly a new international agreement that provides that any nation that enters into a bilateral agreement to supply enriched uranium must supply that uranium if there is no change in the proliferation posture of the nation they are supplying to. This is another initiative that is being considered at the IAEA. I think your point is well taken. You cannot ignore the enrichment side. It has the same difficulties and we need to be alert to how we solve that. Hopefully, by removing the motivations we will go a long way to avoid the proliferation of enrichment facilities around the world.

Mr. McCormack. Let me ask you one more question, because I think we may have in the discussion confused the answer a bit. If you will imagine with me a Barnwell multinational nuclear fuel cycle center serving half a dozen or 10 nations including the United States, it would seem to me that at any given moment one could take a look at the number of nuclear powerplants that are out there being served by the facility in those various nations, and, knowing the type of fuel required, all the specifications are obviously available and being met by somebody someplace, one could make a year's supply of fuel for those plants. It could be simply enriched uranium or it could be mixed oxide fuel, I presume.

Mr. Muntzing. Right.

Mr. McCormack. It could be stored internationally in a bank so that any nation participating would know they had access to a year's supply of fuel independent of any operation of the Barnwell plant. This should provide a great deal of emotional and political security by the way, but it also constitutes, it seems to me, a very substantial international storage of mixed oxides for plutonium.

Now is there anything wrong with that theory?

Mr. MUNTZING. I think it is a very good theory. I recall, Mr. Chairman, your speech before the American Nuclear Society last September in which that concept was discussed and people have been looking at it since then, technical people, who are examining some of these interfaces. The result, as I understand it, from a report I saw recently, is that there is no reason why from both a technical and institutional point of view that that arrangement would be not only acceptable but desirable.

Mr. McCORMACK. Thank you very much.

Mr. Roth, do you have a question?

Mr. ROTH. I thank you, Mr. Chairman, and Mr. Muntzing.

From what I have been able to gather and some of the things I have read and some of our previous testimony over the last 1½ years, I think that to a large degree our nuclear nonproliferation policy is really bankrupt and there must be some new thinking in the administration and some reassessment. And Iwonder if you, because you are a very knowledgeable person, could give us some of the new thinking that is going on in the administration on this.

Mr. MUNTZING. I don't want to pause too long in answer to that question, but I was a little surprised yesterday by the administration's testimony because as I listened to it I did not see any new thinking in it. In fact, it seemed to me there was a step backward in some respects in that they talked again about bilateral arrangements. You know, bilateral arrangements are fine, but when you are dealing with proliferation of nuclear weapons in the world it is not sufficient for a country that no longer has a monopoly over technology in fuels to say, "Let me tell you what we are going to do." Collaboration, not dictation, has to be the guiding principle, I believe.

Unfortunately, I'm afraid that the administration is continuing to think in old ways. When you consider such new concepts such as international plutonium storage concepts, 25 nations met on it in May and essentially the United States and one other country did the most objecting. While I would have hoped that the United States would have been the leader of new concepts and new initiatives, it was the foot dragger. That is disturbing to me. It may be up to the Congress to try to take the leadership in this field because I do not see this administration aggressively pursuing some international consensus beyond what they must do as a minimum.

Mr. ROTH. I appreciate your remarks. I think you are absolutely correct. As far as the administration, I think the onus will have to be on them, because it is pretty hard for Congress to do that. I wish I had the power to do that but I don't. However, we do have a very powerful man in our chairman and maybe we can entice him to do that. But the subjects we talk about here in your remarks, I think, are some of the most important our country is faced with. If we are going to do anything for the future of our country and the world, we have to come to grips with this issue and we are not coming to grips with it.

Mr. MUNTZING. Yes; I would agree with that. The U.S. role in the nuclear field has been a remarkable one, and we have shared our technology and our ideas with people. Many of the great benefits that are accruing is due to the U.S. leadership. Just at the time when we've got some important and difficult problems, I would hope that the United States would not walk away from its prior role as a leader. We seem to be doing that. We are walking away from the breeder. We are walking away from reprocessing. That means we are walking away from new concepts of safeguards. How about the program where you put together satellites and computers and have near real time knowledge about safeguards? We are walking away from those things.

Why should we walk in the other direction? We talk about nonproliferation. The United States is concerned about it. Our idea of how to get there at the moment is self-denial, promises and example. I don't think that works. I think we have to go forward with hard technology, good ideas, new institutions and international cooperation and that's what will pull the world together and make some progress.

Mr. ROTH. All I can say is amen to that because I think you are 100 percent correct. Do you know what we are doing to try to get China and India into the NPT? Are we ever going to be able to do anything there?

Mr. MUNTZING. I think the administration has made great efforts to bring India in as an NPT nation, but the Indians have responded that as a matter of moral philosophy, they will not sign. And I think while great efforts have been made either to have them as an NPT nation or at least to have full scope safeguards, safeguards on all facilities, that so far those efforts have not been successful with India. I would doubt that much progress will be made there in the near future.

With regard to China, China is a weapons nation. There are five official weapons nations, the U.S.S.R., ourselves, France, United Kingdom, and China. And in addition India has demonstrated an ability to explode a nuclear device, having done one as far as we know. But the Chinese are a nuclear weapons nation.

I do not know that they have any particular plans to join the NPT and I don't know that the administration is making any great effort to have them do so.

Mr. ROTH. What you have said about running away from the future is perfect. Yesterday I had the utilities from Wisconsin contact me because they said they've got to find ways to get more coal into Wisconsin because they are building new coal-fired plants. I told them to look to the future and go nuclear, but I don't think they will pay much attention to me. I like your comments because they are right on target and I wish the American people could hear what you have to say.

Mr. MCCORMACK. Thank you. I usually agree with almost everything the gentleman from Wisconsin says, but I think he has exaggerated the potential influence that this chairman has on the administration policies. I wish he were correct. Mr. Muntzing, thank you very much for your testimony today.

Before I call on Mr. Gray, I wonder if I might ask a couple of questions I had for Mr. Kearney. I won't take long because I don't want to run over the clock.

Fundamentally, I would like to ask you, speaking for EEI, what is your perspective on the utilities' view toward nuclear power in general based on the administration position with respect to reprocessing and the breeder program?

Mr. **Kearney**. It is becoming more uncertain. The utility industry is concerned about the whole uncertainty of the nuclear power program and that is certainly a very large part of that uncertainty.

Mr. **McCormack**. Do you believe that if the administration were to change its position and move forward with either Clinch River or a facility such as Clinch River, a new one similar or bigger, the LMFBR, and move forward with the multinational fuel cycle center at Barnwell that it would encourage the utilities to look more favorably at adopting nuclear power in the future?

Mr. **Kearney**. I think it would be a great step forward not only for the utility industry but I think for the administration's objective of trying to solve the proliferation problem. I am sure you appreciate, Mr. Chairman, that there are several uncertainties in the nuclear program, the licensing being another one of them. I think you also are aware that the utility industry feels very strongly about nuclear power and is trying its darndest to fulfill its commitment to nuclear power in the public interest. But it is having difficulty because of these uncertainties. But in summary your suggestions would in our judgment be very, very worthwhile and why don't you use your influence, as Mr. Roth says you can do?

Mr. **McCormack**. What is the utility interest in the light water breeder then? Is there an interest?

Mr. **Kearney**. As an industry there is very little interest in the light water breeder. In our judgment the liquid metal fast breeder reactor is the one that both we and the world in general knows most about. It is one that is at the stage that it can and should be demonstrated and therefore we believe that is the right way to go.

Mr. **McCormack**. Do you think that GESMO should be reinstated or reinstituted? And, if so, would you look to the possibility of commerical mixed oxide fuel for conventional plants?

Mr. **Kearney**. GESMO should definitely be reinstated and we should get on with that. As Dr. Starr pointed out, it is really impossible to know what the economics of thermal recycle are until we have had an opportunity to try it. We are not going to have an opportunity to try it until we get through GESMO and until we get a reprocessing plant in operation. I certainly think, as I pointed out—unfortunately you were not here—to Mr. Wydler that we want to be able to consider that as an option.

Ultimately, of course, I think it is very definite that the best value for plutonium is in the fast breeder. But whether or not we should go into an interim stage is something that is going to depend upon many factors, one of which is the ability just to know what the costs are.

Mr. **McCormack**. Thank you very much, Mr. Kearney. I wanted to get those questions out at this time.

Our last witness this morning is Mr. John Gray of International Energy Associates, Ltd. He is currently chairman of the energy committee and of the nuclear policy working group of the Atlantic Council of the United States. From this broad perspective of involvement in national and international energy matters he is able to provide important information to the subcommittee on the subject of INFCE.

It has been a great pleasure for me to work with Mr. Gray over the years and I have a great deal of respect and admiration for you. I want to welcome you to our committee today.

Without objection, your testimony will in its entirety be inserted at this point in the record. You may proceed as you wish.

[The biographical sketch of Mr. Gray follows:]

JOHN E. GRAY is Principal Consultant and President of International Energy Associates Limited in Washington, D.C.

In addition, Mr. Gray is a Director of the following organizations: GEOMET Exploration, Inc., ABACUS Controls, The Atlantic Council of the United States and the Institute for Public Transportation of New York. He is Chairman of the Energy Committee of the Atlantic Council as well as Chairman of the Working Group on Nuclear Fuels Policy. He is a Member of the National Planning Association - Joint Policy Committee on the Breeder Reactor and Nuclear Proliferation.

Formerly, Mr. Gray was an energy consultant to the Ford Foundation Energy Policy Project, where he authored Energy Policy: Industry Perspectives (1975). He was founding President and Chief Executive Officer of NUS Corporation, an energy supply/environmental consulting engineering firm from 1960 to 1972. He previously held management and technical positions with the Duquesne Light Company, the U.S. Atomic Energy Commission, the U.S. Navy, General Electric Company and Westinghouse.

Mr. Gray graduated from the University of Rhode Island with a B.S. in Chemical Engineering.

NAME: John E. Gray

EDUCATION:

1943 University of Rhode Island, B.S., Chemical Engineering

EXPERIENCE:

12/75 to present
- International Energy Associates Limited, Washington, D.C.
- President and Principal Consultant

Project manager of studies including: "International Cooperation on Breeder Reactors," for the Rockefeller Foundation and principal author of report published May 1978; "Financing of Enrichment Facilities," for Merrill Lynch, Pierce, Fenner & Smith, Inc.; "The Uranium Enrichment Problem: An Assessment of Options," for Duke Power Co., Electro-Nucleonics, TVA, and EEI; "Utility Industry Decision Making Re INFCE," for EEI; "General Environmental Impact Statement on Mixed Oxides (GESMO)," for the GESMO Utility Group (18 electric utilities); "Status and Capability of LWR Suppliers in the U.S.," for Japan Atomic Power Company; "Institutional Options for Nuclear Power Operation in the United States," for Argonne National Laboratory as prime contractor for DOE; "Laser Isotope Separation: Proliferation Risks and Benefits," for Jersey Nuclear-Avco Isotopes, Inc. (Exxon Nuclear Co., Inc.); and "Nonproliferation Alternative Systems Assessment Program - Rolling Report No.3," for Union Carbide Corporation as prime contractor for DOE.

Management reviewer of following studies: "Global Spent Fuel Logistics Systems Study," for Boeing Engineering and Construction as prime contractor for DOE; "Institutional Arrangements for the Reduction of Proliferation Risks," for DOE; "Nuclear Safeguards Technology Transfer Handbook," for Sandia Labs; "Status of Technical Issues Re PWRs and BWRs," for foreign commercial client; "Investor-Owned Electric Utility Financing," for FEA; "International and Multinational Ownership-Management Options," in Barnwell applicability study, for DOE; "Nonproliferation Advisory Service," for multiple clients; "U.S. Government/Industry Decision Making on Energy R&D," for EPRI; "U.S.-U.S.S.R. Cooperation in the Field of Energy," for Department of State; "Assessment of U.S. Utility Operation and Maintenance Experience," for Kansai Electric Co.; "Uranium Enrichment Marketing Service," for Urenco Limited (England); "Three Mile Island: A Preliminary Report on Causes and Impacts," for Oskarshamnsverkets Kraftgrupp AB Aktiebolag (OKG) (Sweden); "Cooperative Laser Enrichment Development," for Exxon Nuclear Co., Inc.; "Advisory Service on International Nuclear Commerce and U.S. Nonproliferation Policy," for various national and international clients; "Intermediate-Term Uranium Supply Curve Estimation," for EPRI; "Analysis of Future Development of Nuclear Power Option in U.S.," for EPRI; "Peaceful Nuclear Technology Transfer," for DOS; "Uranium Supply Analysis," for Dames & Moore as a prime contractor for DOE; "International Oil Transactions," for Computer Data Systems as prime contractor for DOE; "Study of the Potential Uses of the Barnwell Nuclear Fuel Plant," for Union Carbide Corporation as prime contractor for DOE; and "An Assessment of Level of Effort of Non-U.S. Breeder R&D and Demonstration Programs," for Argonne National Laboratory as prime contractor for DOE.

Contributor to all of the above studies plus others on uranium supply, PWRs and BWRs, and high-level waste disposal.

9/74 to present - Atlantic Council of the United States, Washington, D.C.

- Chairman of Energy Committee (12/79 to present)

Responsibility for organization of committee and scoping of studies including global energy relationships and U.S. energy relationships with Japan, Canada, Mexico, Venezuela, and Saudi Arabia.

- Chairman of Nuclear Fuels Policy Working Group (9/74 to 6/78)

Responsibility for organization and coordination of committee and group, scoping of studies, research for and preparation of published reports.

Reports published: Nuclear Fuels Policy (1976), Nuclear Power and Weapons Proliferation (1978).

10/75 to present
- Brookings Institute
- Consultant

10/74 to 12/75
- Edison Electric Institute, Washington, D.C.
- Consultant

Organized and managed studies of the future structure of the enrichment industry and fuels supply. The latter included consideration of the entire LWR nuclear fuel cycle from uranium through high-level radioactive waste disposal (and included sponsorship by and examination of Japanese activities on nuclear fuel supply matters).

Two resulting reports were issued and distributed broadly by EEI: The Future Structure of the Enrichment Industry and Nuclear Fuel Supply Policy.

5/74 to 9/74
- M.I.T. Center for Policy Analysis, Cambridge, Mass.
- Consultant

Participated in preparation of a report on energy research and development policy prepared for the Ford Foundation Energy Policy Project. Published as Energy Research and Development, J. Hollomon, et al. (Ballinger, 1975).

12/72 to - Ford Foundation Energy Policy Project
10/74 - Consultant

Carried out a study of decision making in the U.S. energy industry, including oil, gas, coal, and electric utility industries. Prepared report published as Energy Policy: Industry Perspectives, by J.E. Gray (Ballinger, 1975).

1973 - Contributor, "Nuclear (Atomic) Power," of Mark's Standard Handbook for Mechanical Engineers, 7th edition, 1973 (coauthor with Louis H. Roddis, Jr., et al.)

4/60 to - NUS Corporation, Rockville, Md.
4/72 - President, Chairman, and Chief Executive Officer

Organized, developed, and managed a consulting/engineering firm providing management, technical, and laboratory services on power plants, fuel supply, and environmental problems to U.S. and foreign electric utility companies. NUS grew from 3 to 300 professional employees during the 12-year period. Participated actively in development and conduct of electric utility industry projects in all phases of nuclear power program planning and execution. Established nuclear power consulting firms in Japan and Germany jointly with electric utility companies in those countries. Developed process for production of biomass in solar-intensive regions of U.S. and Puerto Rico.

Prepared numerous reports over 12-year period. Articles and papers during this period included: "The Status of Nuclear Power Stations," prepared for presentation at the International Meeting on Modern Electric Power Stations, Liege, Belgium, May 11-15, 1970; "Atomic Power -- Its Problems and Future," Public Utilities Fortnightly, June 1962; and "Nuclear Energy's Growing Pains -- Practical Problems Ahead," Public Utilities Fortnightly.

4/54 to - Duquesne Light Company, Pittsburgh, Pa.
4/60 - Project Manager, Shippingport Atomic Power Station

Responsible for directing Duquesne Light Company activities in development, design, construction, training, startup, and initial operation of first large nuclear power control station.

4/50 to - Savannah River Operations Office, U.S. AEC
4/54 - Director, Technical and Production Division

Responsible for all technical and manufacturing activities at Savannah River thermonuclear weapons materials plant. Included uranium, heavy water, production reactors, reprocessing, plutonium fabrication, and high-level radioactive waste disposal facilities.

10/48 to - Navy and U.S. AEC Naval Reactors Branch
4/50 - Materials Administrator

Responsible for establishing programs for production and irradiation testing of nuclear fuel elements and reactor materials for nuclear submarine program.

9/46 to - General Electric Company
10/48 - Director, Material Section, Atomic Power Dept., General Engineering and Consulting Laboratory (Schenectady, N.Y.); and Senior Design Engineer, Engineering Division (Hanford Works)

Directed materials development program for Project "Genie" (NaNaK cooled nuclear reactor heat transfer system). Designed plutonium weapons components production process equipment.

STATEMENT OF JOHN E. GRAY, PRESIDENT, INTERNATIONAL ENERGY ASSOCIATES, LTD.

Mr. **Gray**. Thank you, Mr. Chairman. I would like to commend you for the clarity and character of the questions that came forward in the letter inviting me to testify and I would like to respond to those questions, if I may.

Mr. **McCormack**. I must give the staff credit for the clarity and probably most of the ideas of what the questions should be.

Incidentally, in case you ladies and gentlemen are not conscious of Mr. Gordon Chipman on this side and Mr. Bob Leachman on this side as two of the key staff members working with the subcommittee, they are both outstanding experts in the field to whom those on the committee owe a great deal of credit for what we do. So your commendation is really for the staff members. Go ahead, Mr. Gray.

Mr. **Gray**. Thank you, Mr. Chairman.

First, I would comment on the implications of INFCE for the future of U.S. nonproliferation policies. And I believe and have before testified that INFCE has served a number of useful purposes. Importantly, it has served to develop a shared understanding of both the proliferation risks and the benefits of the sensitive parts of the fuel cycle. Such a common understanding is essential in any ensuing political negotiations on an effective and acceptable new nonproliferation regime.

An important achievement of INFCE is the demonstration that complex and potentially divisive nuclear issues can be constructively and objectively dealt with in a forum in which both suppliers and recipients participate. INFCE has clearly heightened international consciousness of the proliferation hazards as to the widespread use of plutonium. Also there is general recognition that the energy values of plutonium cannot be abandoned.

In the context of INFCE, an important consensus appears to have been developed on breeders. INFCE has also been important in the area of dealing with the growing quantities of separated plutonium by serving to reinforce support for IAEA's work on international plutonium management. There is considerable optimism about establishing arrangements under which plutonium stocks are placed under genuine international custody.

Such arrangements are of major potential importance to the future nonproliferation regime. I would say in sum that INFCE has established the viability of broad international consultation on sensitive nuclear power matters, and has revealed a surprisingly large area of common ground on the nature of the intertwined energy supply/proliferation problem, as well as on possible elements of a solution. It is possibly a base for a new consultative mechanism to be used as part of new nonproliferation machinery.

However, whether INFCE was merely a 2-year interlude, or a significant determinant in the development and use of nuclear energy for peaceful purposes may depend in large measure on whether the United States exerts an open, unrestrictive leadership in the context of the lessons of INFCE and of international cooperation.

Now turning to your four questions, the first is:

What is the importance of U.S. nuclear technological leadership as well as our reliability as a supplier for attaining U.S. nonproliferation goals and for influencing how other countries use nuclear power?

The simple answer to your question is that both U.S. technological leadership and reliability as a supplier are of paramount importance for attaining U.S. nonproliferation goals and for influencing other countries nuclear power programs. Both are very powerful tools which were in large measure set aside without apparent realization of their fundamental importance or the difficulty of substituting U.S. law and persuasion for them. U.S. capacity for both technological leadership and reliability is still available, if the administration and the Congress care to allow its use.

Next question: "What should be done to reestablish this leadership and reliability?"

There are opportunities in several key areas: enrichment, spent fuel storage, reprocessing, radioactive waste management and breeder development and demonstration, also operation and maintenance of LWR's, considering both safety and economics, as well as safeguards technology. I will discuss each of these areas very briefly.

A report that President Carter sent to Congress last October dealt with cooperation on U.S. uranium enrichment facilities. That report identified key issues which I won't repeat, but that report itself suggests to me the prospect of multinational cooperation on laser enrichment demonstration and supply capacity. This cooperation could accommodate the interests of the existing multinational enrichment institutions, as well as those of nations, such as the United States, Japan and others not now engaged in multinational programs. Such an activity initiated by the United States could provide leadership, supply security and nonproliferation benefits. The technology has the potential for major economic and natural uranium utilization advantages. Also, recent studies have concluded that laser enrichment may be more, rather than less, proliferation resistant.

Spent fuel storage is a practical necessity throughout the world. How, where, and when to store spent fuel involves decisionmaking which bears directly on other international fuel cycle activities. Constructive, positive U.S. contributions to this decisionmaking should help.

Reactivation of the GESMO proceedings should help. Not being willing to even look at the economic and environmental realities of mixed oxides won't help. In any event reprocessing is a practical necessity for breeder development. There is a clear opportunity here for U.S. leadership.

Radioactive waste management is a dominant international problem. The U.S. approach may be part of the problem. It has been suggested that a U.S. radioactive waste authority be established and given authority, responsibility and accountability for the matter. This, or some equally forceful initiative, could provide for more significant U.S. contributions, if not leadership. The present U.S. situation precludes both.

On the matter of breeders, I've set forth in the statement again the recommendations of the Rockefeller Foundation Report of 1978, and I won't repeat those, except to call your attention to the last of this series; namely, that the United States and Japan—and possibly the United Kingdom—should plan a joint breeder demonstration program. Eventual participation of additional countries, particularly the

United Kingdom, should be provided for. The continental European breeder program is already closely integrated, and no specific recommendation is made in this regard. There had been serious interest before 1978 and since 1978 on the part of the United Kingdom and Japan in cooperative breeder demonstration programs with the United States. However, since the United States continues to demur from committing itself to breeder demonstration, this serious interest may have waned, and in my opinion, continues to wane. Consequently, the United States continues to negate willingness, much less reliability in this area and to deny itself the possibility of any serious international leadership in the practical resolution of the strongly interrelated breeder deployment/reprocessing/safeguards/export issues.

With reference to LWR's, there continues to be practical opportunities in demonstrating how to regulate, operate and maintain LWR's safely and economically. This may be considered emphasis on the nuts and bolts of how to do things correctly and certainly—but this is what technological leadership and reliability can be all about.

Finally, on the matter of safeguards technology, there is a need for the further development and application of this technology. The United States has significant relevant capacity in being but lacks working experience with the full range of sensitive commercial facilities to be safeguarded and therefore cannot demonstrate to its own satisfaction, or to that of others, the costs and benefits of this technology. This makes it difficult to be a reliable leader.

Next question: "In light of INFCE, where do you think priority should be given in U.S. R.D. & D. for nuclear power?"

I have already suggested a series of priority action items, which can be considered either in light of INFCE, or without regard to INFCE. However, in response I suggest the following priorities:

1. Enhancement of the safety, economics, and regulation of U.S. LWR's and of the ability to build and operate them faster, cheaper, and safer.

2. Firming up of the entire LWR fuel cycle, including advanced enrichment technology, spent fuel storage and transportation, and radioactive waste management. Turn the GESMO proceedings back on, and see where that leads.

3. Develop and demonstrate one or more commercial-scale breeders and associated fuel cycle activities—and safeguards technology and systems. Do this cooperatively with other nations, including the United Kingdom, Japan and others.

4. Develop and demonstrate plutonium and enriched uranium safeguards technology and institutions, cooperatively with other nations.

Last question: "What is the validity of INFCE's linking of assurances of supply with assurances of nonproliferation?"

The linkage appears to be very real and clear. For example, if one presumes that the IPS is prospectively the keystone of an internationally acceptable nonproliferation regime, then support of IPS, especially by many of the nonindustrial nations, is most likely to be dependent on assurances of supply. Based on my recent discussions with a cross section of the foreign community, the validity of this linkage is a given.

In conclusion, the availability, refinement, and further development of the nuclear power option continues to be of fundamental importance both to the United States and to the international community. For the United States to reestablish international confidence as a supplier, and influence in achieving nonproliferation objectives, are both becoming increasingly difficult—because our own nuclear program, overall continues in a state of disarray and indecision.

This results in increasing lack of confidence in U.S. leadership and reliability. This can be turned around, but only if we in fact provide technological leadership and become reliable. Industrial capacity to support this turn-around is available. That capacity, supported by and working cooperatively with, the U.S. Government is what made the United States a reliable leader in the first place. Current support and decisiveness by the administration and Congress appear to be much less certain. These appear to have the key to confidence, leadership and reliability. The continuing efforts of this subcommittee are striking examples of what we need more of.

And I was glad to hear confirmed this morning that you have all the power in the world to do all these things. Thank you, Mr. Chairman.

[The prepared statement and additional Q's & A's asked of Mr. Gray follows:]

TESTIMONY PRESENTED BY JOHN E. GRAY, INTERNATIONAL ENERGY ASSOCIATES LTD., (IEAL)

Thank you, Mr. Chairman. I am John E. Gray of International Energy Associates Limited of Washington, D.C. I also serve as Chairman of the Energy Committee and of the Nuclear Policy Working Group of the Atlantic Council of the United States. I am grateful for this opportunity to appear before your Committee and provide my thoughts on certain matters, as you requested.

You have asked for comment on the implications of INFCE for the future of U.S. nonproliferation policies and the proliferation risks in the 1980's. I will provide that comment and then address the four specific questions you have asked that I respond to.

The INFCE process has served a number of useful purposes. It has served to develop a shared understanding—in effect, a data base—of both the proliferation risks and the benefits of the sensitive parts of the fuel cycle. Such a common understanding, or even some consensus on the range in which these risks and benefits fall, is essential if any ensuing political negotiation on an effective and acceptable new nonproliferation regime are to have a chance for success.

An important achievement of INFCE is the demonstration that complex and potentially divisive nuclear issues can be constructively and objectively dealt with—in a forum in which both suppliers and recipients participate. INFCE has also paid dividends by providing an important focal point and backdrop for the continuing nonproliferation dialogue, including bilateral and ad hoc multilateral discussions.

Substantively, INFCE has equal or greater impact. It has clearly heightened international consciousness of the proliferation hazards of the widespread use of plutonium. Also, there is a general recognition that the energy values of plutonium cannot be abandoned. While there is an obvious tension between these two attitudes, INFCE has fostered a growing conviction that they can be reconciled. The so-called "technical fix" has receded in prominence, in what many participants regard as one of the paramount results of INFCE to date.

Also, there is a perception that, within the context of INFCE, an important consensus appears to have developed on breeders, including prospective capital costs of first FBRs, development costs, prospective reductions in capital costs, the unattractiveness of premature deployment on inadequate power grids, and a rationale for cooperative arrangements for reprocessing.

INFCE seems to have provided a generally accepted measure of the proliferation risks and energy supply benefits of plutonium recycle so that subsequent political discussions will take place in a more realistic technical framework. INFCE also has been important in the area of dealing with the growing quantities of separated plutonium, by serving to reinforce support for IAEA's work on international plutonium management. There is considerable optimism about establishing arrangements under which plutonium stocks are placed under genuine international custody. Such arrangements are of major potential importance to the future nonproliferation regime. If established, international storage will constitute the first instance in which an international authority would have the responsibility not only of verifying the use of sensitive material, but of actually controlling it as well, retaining physical custody, and releasing it for use only when agreed conditions are met.

In sum: INFCE has established the viability of broad international consultation on sensitive nuclear power matters, and has revealed a surprisingly large area of common ground on the nature of the intertwined energy supply/proliferation problem, as well as on possible elements of a solution. It is possibly a base for a new consultative mechanism to be used as part of new nonproliferation machinery.

However, whether INFCE was merely a two-year interlude, or a significant determinant in the development and use of nuclear energy for peaceful purposes may depend in large measure on whether the U.S. exerts an open, unrestrictive leadership in the context of the lessons of INFCE and of international cooperation.

Now turning to your four questions, the first is: "What is the importance of U.S. nuclear technological leadership as well as our reliability as a supplier for attaining U.S. nonproliferation goals and for influencing how other countries use nuclear power?"

The importance of U.S. technological leadership to U.S. diplomacy was well set forth in the June 1976 Congressional Research Service report titled "Science, Technology and Diplomacy in the Age of Interdependence". The finding of this study was "that U.S. diplomacy is neglecting two powerful instruments of policy formation and policy execution: Technical expertise and management skill." The report is strongly supportive of international cooperation on development and application of technology—with a strong U.S. presence, in its own self-interest.

The imprint of U.S. technological leadership on international nuclear practices, programs and projects is unmistakable. However, the U.S. may today be missing unusual opportunities to use international cooperation on nuclear research and development as the powerful instrument it could be in support of international energy supply and nonproliferation goals.

The simple answer to your question is that both U.S. technological leadership and reliability as a supplier are of paramount importance for attaining U.S. nonproliferation goals, and for influencing other countries' nuclear power programs. Both are powerful tools which were in large measure set aside, without apparent realization of their fundamental importance, or the difficulty of substituting U.S. law and suasion for them. U.S. capacity for both technological leadership and reliability is still available if the Administration and the Congress care to allow its use.

Next question: "What should be done to reestablish this leadership and reliability?"

There are opportunities in several key areas: enrichment, spent fuel storage, reprocessing, radioactive waste management and breeder development and demonstration. Also operation and maintenance of LWRs, considering both safety and economics, as well as safeguards technology. I will discuss each of these areas very briefly.

President Carter's October 5, 1979 Report to the Congress on U.S. Uranium Enrichment Capacity addresses the desirability of and options for foreign participation in new U.S. uranium enrichment facilities, presumably with centrifuge capacity in mind. The report identifies the key issues as: technology control, so as to minimize the proliferation risks; improvement of fuel supply assurances; assurance of U.S. control of facilities; and conditions required of foreign participants. The report suggests (to me) the prospect of multinational cooperation on laser enrichment demonstration and supply capacity. This cooperation could accommodate the interests of the existing multinational enrichment institutions as well as those of nations, such as the U.S., Japan and others not now engaged in multinational programs. Such an activity initiated by the U.S. could provide leadership, supply security and nonproliferation benefits. The technology has the potential for major economic and natural uranium utilization advantages. Also, recent studies have concluded that laser enrichment may be more, rather than less, proliferation resistant.

Spent fuel storage is a practical necessity throughout the world. How, where and when to store spent fuel involves decision making which bears directly on other international fuel cycle activities. Constructive, positive U.S. contributions to this decision making should help.

Reactivation of the GESMO proceedings should help. Not being willing to even look at the economic and environmental realities of mixed oxides won't help. In any event reprocessing is a practical necessity for breeder development. There is a clear opportunity here for U.S. leadership.

Radioactive waste management is a dominant international problem. The U.S. approach may be part of the problem. It has been suggested that a U.S. Radioactive Waste Authority be established and given authority, responsibility and accountability for the matter. This, or some equally forceful initiative, could provide for more significant U.S. contributions, if not leadership. The present U.S. situation precludes both.

On the matter of breeders, I'll try again the recommendations of the Rockefeller Foundation report of 1978:

"The U.S. should continue to develop (LMFBR) breeders as insurance against possible future resource depletion. For such an approach to be credible, breeders should be proven as an option through the demonstration of commercial-size units.

"The U.S. should take steps to move back into a position of technological leadership on the breeder reactor and particularly on the breeder fuel cycle and nonproliferations measures.

"The U.S. government should recognize that continued international exchange and cooperation on R&D, demonstration, and safety and licensing may make nonproliferation-related agreements easier to achieve.

"The U.S. and Japan—and possibly the U.K.—should plan a joint breeder demonstration program. Eventual participation of additional countries, particularly the U.K., should be provided for. The continental European breeder program is already closely integrated, and no specific recommendation is made in this regard. However, the U.S. and others should recognize that that group is open to additional interchanges, particularly on a commercial basis."

There has been serious interest before and since 1978 on the part of the U.K. and Japan in cooperative breeder demonstration programs with the U.S. However, since the U.S. continues to demur from committing itself to breeder demonstration, this serious interest may have waned. Consequently, the U.S. continues to negate willingness, much less reliability in this area and to deny itself the possibility of any serious international leadership in the practical resolution of the strongly interrelated breeder deployment/reprocessing/safeguards/export issues.

With reference to LWRs, there continue to be practical opportunities in demonstrating how to regulate, operate and maintain LWRs safely and economically. This may be considered emphasis on the nuts and bolts of how to do things correctly and certainly—but this is what technological leadership and reliability can be all about.

Finally, on the matter of safeguards technology. There is a need for the further development and application of this technology. The U.S. has significant relevant capacity in being but lacks working experience with the full range of sensitive commercial facilities to be safeguarded and therefore cannot demonstrate to its own satisfaction, or to that of others, the costs and benefits of his technology. This makes it difficult to be a reliable leader.

Next question: "In light of INFCE, where do you think priority should be given in U.S. RD&D for nuclear power?"

I have already suggested a series of priority action items, which can be considered either in light of INFCE, or without regard to INFCE. I say this, because whatever the value of INFCE, it has in large measure not suggested significant changes in technical areas. A notable exception may be its contribution to deemphasis on recycle of plutonium in LWRs.

However, in response, I suggest the following priorities:

1. Enhancement of the safety, economics and regulation of U.S. LWRs and of the ability to build and operate them faster, cheaper and safer.
2. Firming up of the entire LWR fuel cycle, including advanced enrichment technology, spent fuel storage and transportation, and radioactive waste management. Turn the GESMO proceedings back on, and see where that leads.
3. Develop and demonstrate one or more commercial-scale breeders and associated fuel cycle activities—and safeguards technology and systems. Do this cooperatively with other nations, including the U.K., Japan, and others.

4. Develop and demonstrate plutonium and enriched uranium safeguards technology and institutions, cooperatively with other nations.

Last question: "What is the validity of INFCE's linking of assurances of supply with assurances of nonproliferation?"

The linkage appears to be very real, and clear. For example, if one presumes that the IPS is prospectively the keystone of an internationally acceptable nonproliferation regime, then support of IPS, especially by many of the nonindustrial nations, is most likely to be dependent on assurances of supply. Based on my recent discussions with a cross section of the foreign community, the validity of this linkage is a given.

In conclusion, the availability, refinement and further development of the nuclear power option continues to be of fundamental importance both to the United States and to the international community. For the U.S. to reestablish international confidence as a supplier, and influence in achieving nonproliferation objectives, are both becoming increasingly difficult—because our own nuclear program, overall, continues in a state of disarray and indecision. This results in increasing lack of confidence in U.S. leadership and reliability. This can be turned around, but only if we in fact provide technological leadership and become reliable. Industrial capacity to support this turnaround is available. That capacity, supported by and working cooperatively with, the U.S. Government is what made the U.S. a reliable leader in the first place. Current support and decisiveness by the Administration and Congress appear to be much less certain. These appear to have the key to confidence, leadership and reliability. The continuing efforts of this Subcommittee are striking examples of what we need more of.

Thank you.

COMMITTEE ON SCIENCE AND TECHNOLOGY,
U.S. HOUSE OF REPRESENTATIVES,
Washington, D.C. June 11, 1980.

JOHN GRAY,
President, International Energy Associates, Ltd.,
Washington, D.C.

DEAR MR. GRAY: Thank you once again for appearing before the Subcommittee on Energy Research and Production during our June 5 meeting on the International Nuclear Fuel Cycle Evaluation study, and the implications for future nuclear energy research and development. We found your testimony particularly insightful and useful, and we sincerely appreciate your sharing your expertise with us.

During the hearing, we indicated that the Subcommittee might request some additional information in the form of further questions. Having reviewed the testimony at the hearing, we find that additional information would be very helpful. Accordingly, we would appreciate your providing, for the record, reponses to the enclosed questions.

Your prompt reply would be most appreciated. Thank you for your cooperation on this matter.

Sincerely,

MIKE MCCORMACK,
Chairman, Subcommittee on Energy,
Research and Production.

Enclosure.

QUESTIONS FOR MR. JOHN GRAY, FOLLOWING INFCE HEARINGS, JUNE 5, 1980

1. A recent GAO report issued March 18, 1980, concludes that the Administration's policy of indefinitely deferring commercial reprocessing within the United States has adversely affected research and development efforts to provide adequate safeguards for domestic nuclear fuel reprocessing plants. The report further points out that U.S. non-proliferation policy has also adversely affected the adoption of international safeguards for the production, storage and use of plutonium. Now that INFCE is completed, what steps do you believe should be taken to address these serious deficiencies?

2. What are the effects on our nuclear and non-proliferation leadership of not proceeding with Clinch River?

3. Would increased cooperation in breeder reactor R&D with other countries be in our interests? If so, how could this be structured?

4. Now that INFCE is over, what effect do you think it can have on the scope and direction of breeder RD&D?

5. What are the most profitable future directions for U.S. non-proliferation policy?

6. How important is leadership in enrichment technology to our international posture and the effectiveness of our non-proliferation policy?

7. Can you suggest any steps which would strengthen the U.S. as a low cost, reliable supplier of enrichment services?

8. What are your recommendations on the use of Barnwell?

9. Has non-operation of Barnwell affected the actions or policies of any other countries in regard to reprocessing? Since other countries are proceeding with reprocessing, how can we defend to the American public and the investors we encouraged to build the plant, its non-operation as an "example"?

INTERNATIONAL ENERGY ASSOCIATES, LTD.

July 8, 1980.

Hon. MIKE MCCORMACK,
Chairman, Subcommittee on Energy Research and Production,
Committee on Science and Technology,
Rayburn House Office Building,
Washington, D.C.

DEAR MIKE: Pursuant to your letter of June 11, I offer the following responses to the enclosed questions:

1. Have DOE undertake a program of developing adequate safeguards for reprocessing plants, jointly with other national groups—such as the U.K., F.R.G., France, Japan; cooperate with and provide technical and political support for the IAEA in its development of the IPS system and the promulgation of international safeguards.

2. I am not certain that the (negative) effects are relatable to Clinch River, per se. Certainly, not proceeding with a full-scale demonstration plant of some sort precludes any leadership.

3. Increased cooperation in breeder R&D and Demonstration would clearly be in our interest. It can be structured wiith the Japanese and the British and should be carried out through an industrial organization, or consortium committed to or established for this purpose.

4. INFCE, concluded, can have a positive effect on the scope and direction and purpose of breeder RD&D. INFCE has provided a consensus and a framework which could provide for structuring an international cooperative program in keeping with the findings of INFCE.

5. Selective cooperation with nations which are committed to careful further development of nuclear power and political and technical enhancement of nonproliferation measures.

6. Could be very important, if we can use our advanced technologies—such as laser enrichment—as a carrot for causing other nations to work with us on improving the economies of U.S. and their enrichment services supply and stretching of uranium resources; as well as working more cooperatively on developing mutually acceptable nonproliferation policies.

7. Set up a corporation, government or private, with the singular responsibility of supplying the world market with enrichment services at the lowest possible cost; move vigorously to build commercial gas centrifuge capacity; demonstrate and commercialize the laser enrichment technology; prepare to retire the gaseous diffusion capacity—all of the foregoing having to do with steps which would be expected of an institution which wants to be regarded, longterm as a low-cost, reliable, major supplier of enrichment services.

8. Put it into operation as a reprocessing plant dedicated to providing plutonium for U.S. breeder reactor RD&D; concurrently develop and demonstrate safeguards technology and methods suitable for U.S. and international application; do the latter development cooperatively with other nations, or with the IAEA—to enhance its international acceptability and utility.

9. Non-operation of Barnwell appears to have failed in accomplishing its objective of dissuading other nations from reprocessing. However, it may have contributed to the demise of recycle as a firmly planned step in the LWR fuel cycle. (Conversely, non-operation precluded getting a handle on demonstrated commercial-scale costs of recycle which, if too high, may have dissuaded other nations from reprocessing except for Pu feed for breeder RD&D programs.)

I trust that the above responses provide you with information which you will find helpful.

Sincerely,

JOHN E. GRAY, *President.*

Enclosure.

Mr. McCormack. Thank you, Mr. Gray.

I'm afraid I've been hung out by my friends here. I should say, however, for those of you who are not aware of it that yesterday the full committee, the Committee on Science and Technology, passed four pieces of legislation, all of which are of considerable importance. The first is simply title I of the DOE authorization bill as it was passed by the entire committee, that is the research, development and demonstration program, including all of our nuclear programs.

The committee, at the request of the gentleman from New York, Mr. Lundine, removed all reference to West Valley and all the provisions associated with West Valley that had been in the bill and included those in a separate new bill which is exactly the same material, which will now be referred to other committees such as the Committee on Commerce and perhaps Interior.

At the same time the West Valley bill and the title I bill were reported out, we reported out the Fusion Research, Development and Demonstration Act of 1980, bringing the total authorized funding for 1980 into conformance with the action of the full committee at $434 million, approximately, for fiscal 1981 and moving the effective date for the engineering test facility from 1986 back to 1987. That bill has been reported out. And, finally, a radioactive waste bill has been reported out which includes the features of the DOE authorization bill, that is, a demonstration program for four geologic technology demonstration repositories to be on line by the end of this decade, the first by 1986, the second by 1987 and the third and fourth by 1990, each to contain at least 40 cannisters of glassified high level waste. These facilities are to be unlicensed demonstration facilities.

In addition, the same legislation directs the Department of Energy to undertake research, development, and demonstration programs into the glassification of low-level waste at each nuclear powerplant or each group of nuclear powerplants in the country, to accept all low-level radioactive waste from the surrounding area and become sort of a friendly vacuum cleaner for all low-level waste for its region of the country. Those wastes are to be glassified so that all low-level wastes in the country would be glassified and finally to study the storage of such glassified low level wastes in the weapons test caverns of the Southwest.

The bill also provides for a research, development and demonstration program of the storage of older spent fuel in air, that is, dry storage in existing canyons such as in Federal buildings or near reprocessing centers in the country, so that there would be additional storage space where older fuel elements could be moved.

All of this legislation has now been reported out of full committee and will go, of course, to the Rules Committee. I think we are moving forward with a positive program. This legislative group of bills does not contain everything we would like, but it does move forward. Of course, it does include authorization for continuation of the Clinch River project, for the funding of Barnwell, for negotiations to purchase the Barnwell facility by the Federal Government, continuation of the high temperature gas-cooled reactor program and continuation of our reprocessing programs. So all of those are included in the authorization bill.

Since you touched on a number of these in your testimony, Mr. Gray, I just wanted to bring everyone in the room up to date as to where we are at the present time.

Mr. **Gray**. Congratulations on a good day's work.

Mr. **McCormack**. Thank you, Mr. Gray. I assure you it was more than a day.

I have two questions I would like to ask and one is: You have done the specific studies on Barnwell and made, I believe, recommendations to Department of Energy on this subject, and I would like to ask you how you see the Barnwell facility developing and what you would recommend specifically for it, especially if there was anything different from what we have discussed here today.

Mr. **Gray**. First, we did a study on prospective uses of Barnwell and an analysis of those uses. We were not asked to make recommendations regarding a specific use of Barnwell. We were asked to identify prospective uses.

Mr. **McCormack**. Would you care to informally comment on what your recommendations might be?

Mr. **Gray**. Is it possible to comment informally in this particular context?

Mr. **McCormack**. You are commenting to us and not to the Department of Energy at least.

Mr. **Gray**. I think it is fair to say that the prospective uses that were identified and analyzed and which appear realistic in terms of the needs for the use of such a facility include: the use of Barnwell as an AFR; and Barnwell as a facility which is amenable to serious work on safeguards technology, training and demonstration, especially if one activates Barnwell as a reprocessing plant. A key prospective use for Barnwell as a reprocessing plant would be to provide plutonium for breeder demonstration and development programs, there being no obvious supply of same except from our military weapons programs here in the United States at the present time.

To me this is an interesting and practical way to put Barnwell to use. Barnwell is a solution sitting there waiting for a problem to be defined that fits it. And I believe there are many such problems that can be defined.

Barnwell is certainly amenable to being used as an important facility by the United States in evoking cooperation from other nations in whatever form of multinational or international enterprise one cares to build around it. It is a remarkable capacity in being and in my opinion could and should be used very constructively in dealing with how the United States provides leadership in these key areas, all of which are inevitably embraced by the nonproliferation externality.

Mr. **McCormack**. Would you anticipate converting it into some sort of coprocessing facility, if it were to go into operation?

Mr. **Gray**. I don't see that as a key decision myself. I think that could be done constructively. If that is a desirable thing to do, certainly Barnwell can be so contrived.

Mr. **McCormack**. Assuming a step to put at ease the natural apprehensions some persons have about diversion of material, if it were to produce no material at any time that would be useful in weapons?

Mr. **Gray**. Absolutely.

Mr. **McCormack**. What about having an advanced fuel fabrication facility adjacent to the reprocessing plant?

Mr. **Gray**. Manning Muntzing touched on this and I thought rather well—if one can define the realistic demand for a given design of spent fuel, then it could make sense to have that particular facility to provide such fuel there at Barnwell. Manning Muntzing said it well: You cannot design and fabricate fuel in the absence of knowing that it is meeting the specifications of those who will put it into a reactor.

Mr. **McCormack**. Mr. Roth, do you have a question?

Mr. **Roth**. I have a question, Mr. Chairman. I very much enjoyed your testimony, Mr. Gray. You seem to, of course, give quite an indictment of U.S. decisionmakers and I think that your points are well taken. But I wonder if you could zero in a little bit more. Just who is to blame for the problems we've got. Is it this committee? Is it the entire Congress? Is it the President? Who is it? The Secretary of Energy?

Mr. **Gray**. Thank you for a very demanding question.

Mr. **McCormack**. You don't have to answer that question, if you don't want to, Mr. Gray.

Mr. **Gray**. I would not engage in trying to identify the personalities involved. I would say that if one takes a broad view of this matter—and there have been many testifying before you, especially those before me here today, who have presented a broad view. I think we lost sight of the fundamental. We ended up emphasizing an externality, a very demanding externality; namely, nonproliferation, and I think we went to work on the externality and lost sight of the fundamentals of the problem we were working with. And you cannot deal with the externality without relating it to and internalizing it, as my economist friends tell me, with the fundamental problem you are trying to deal with.

I sat with an administration official 3 years ago who wanted to call a meeting of folks to talk about how to develop alternative fuel cycles which would be proliferation resistant. He listed a bunch of names. There was included in that list of names no one representing any of the U.S. scientific industrial organizations that are in this business nor any of the associations related to those industrial organizations. I advised that it was a great idea to have such a meeting but why not have at such a meeting those people who can either make those things happen or who can tell you that they can't be made to happen on a practical basis? I left that particular office that day feeling that I had done a constructive service in helping somebody understand that the technical industrial realities had to be taken into account in the first instance in doing our national planning and in the approach to the whole nonproliferation thing. That concept was accepted that day as being a good one but nothing was done as a consequence.

I have seen over the past few years a gross dichotomy between the practical industrial—I include the whole research and development and industrial infrastructure—between it and the policymakers. I believe simply that policy has been made and implemented in a vacuum and the system has not availed itself of the practical advice of some of the fellows who have sat here before you and have preceded me this morning. That's hard fact as far as I'm concerned.

Mr. **Roth.** I appreciate your response. I know the chairman may think it unkind of me but I just want to make this observation. In our hearings we have a lot of shadowboxing. I know you are very conversant with the subject and I appreciate your candor, but there is almost too much diplomacy and too much tact. I was hoping for someone to come in sometime and just lay it right on the jaw instead of shadowboxing and say, look, you've got to make these changes and you've got to do this and do that. Then I think we would come to a better resolution of some of these problems. I could be wrong on that and probably am, Mr. Chairman.

Mr. **McCormack.** Well, I think no one can argue with your position, Mr. Roth, that we are dealing with an awkward situation and we all know what it is and because it is so awkward, it is difficult for us. It is obviously difficult for us to handle in testimony. I am sure that none of us, neither members of the committee nor witnesses, wish to embarrass anyone else unnecessarily. I think what we must do—and I very much appreciate your determination to do this with me—is to figure out ways to solve our problems and to move forward.

Mr. **Roth.** Mr. Chairman, just allow me to add this comment. Even with, for example, not only the Government but the utilities, I have many people contact me and say—carry on the fight. We have to have nuclear energy and so on, but I think that utilities acquiesce too easily and say, well, it is too hard so we'll go build coal plants and they come to me and say, hey, we've got to find ways to get more coal to Wisconsin and so on. We have to put up the fight, yes; but I think we have to have help from other groups too.

Mr. **McCormack.** Let's ask Mr. Kearney if he wants to comment on that.

Mr. **Kearney.** Mr. Chairman, I think we in the utility industry like to feel that we are in the forefront of trying to accomplish these things. You made reference to both coal and nuclear and our position is as an industry that we need both coal and nuclear. Our frustration is that there are many sorts of mission oriented regulatory agencies, both at the Federal level and at the State level and we just can't cope with it completely by ourselves. It is just impossible. I'd like to think, Mr. Roth—you refer to Wisconsin and I'm very familiar with many of the utility executives in Wisconsin—that they are fighters. I think they are trying to do the best they can.

You may be aware, and I'm sure you are, that the Public Service Commission in Wisconsin just almost flat out said that they couldn't build another nuclear plant and it is almost a fait accompli. It is difficult to deal with those things.

Mr. **Roth.** I realize that and I am not indicting the people of Wisconsin. They are probably the most forward looking. But Mr. Muntzing said something I think that's really the crux of the problem. He talked about looking to the future and we always have societies throughout history that either look to the past or look to the future and I feel that we are starting to look to the past too much. It is not only the fault of Toby Roth here in Congress or other

Congressmen, but I think it is the fault of our industry. It is easier to acquiesce so we just give in. It is easier to build a coal plant so we're going to build a coal plant. Well, coal is 19th century and we should be looking at the 21st century. This is the thing that I cannot seem to reconcile in my thinking when I talk to these people and people say get in there and fight, but when you look around there is nobody there behind you.

Mr. KEARNEY. I will take your message back, Mr. Roth.

Mr. ROTH. Don't take it back to Wisconsin. Take it to New York or some place else. [Laughter.]

Mr. KEARNEY. I'm sure they have the message in Wisconsin.

Mr. MCCORMACK. I thank you gentlemen very much for your testimony.

I want to say that I believe that these hearings are building an invaluable record for the future. I believe that in spite of the fact that we are only discussing the situation from the perspective of one subject area, that they are very valuable and I believe the contributions of all of you and the members of the committee who have come—I wish we could have more members of the committee here and I have been working on getting more of them here this afternoon. But I believe that your testimony is making a real contribution which may be felt more in the future than it is today. I certainly have confidence that this country will move forward along the lines we have been discussing today.

Mr. GRAY. May I say one word with regard to Mr. Roth's very important point. You are sitting here as a member of an action-oriented subcommittee and action-oriented congressional committees coupled with an action-oriented administration on nuclear power and all of the matters we have been talking about here will find that there is available to it an industry which is begging to be activated. You gentlemen are part of the solution as far as I'm concerned, within your context of congressional authority. That is a very important and dominant factor. And if you can get, or if we all can get within the administration a similar sense of it being necessary to take constructive action, you can have a remarkable return to U.S. leadership and perception and reliability fast.

Mr. MCCORMACK. Mr. Roth and I will be working in those directions.

This afternoon at 2 o'clock the committee will reconvene. We will have at that time Dr. Cunningham, Assistant Secretary for Nuclear Energy of the U.S. Department of Energy, accompanied by Dr. Marvin Moss, Associate Director of Nuclear Nonproliferation, Office of Energy Research, DOE. We will have Myron Kratzer, principal staff consultant, International Energy Associates, Ltd., and Dr. John Lamarsh, chairman, Department of Nuclear Engineering, Polytechnic Institute of New York.

I also want to say that earlier during this session I introduced a couple of the staff members. I failed to introduce the staff director who has pulled this all together and whose management makes it all possible, and that is Mr. Steven Lanes sitting over here, in case any of you don't know him. There is a tremendous amount of work that goes into every hearing and every series of hearings. Mr. Lanes is the one who coordinates it all.

I thank you very much. We will recess at this time and reconvene at 2 p.m. today.

Afternoon Session

Mrs. Bouquard. Good afternoon, ladies and gentlemen.

We will now begin our final session of the hearings on the international nuclear fuel cycle evaluation.

Our first witness this afternoon is Dr. George Cunningham, who is the Assistant Secretary for Nuclear Energy in the Department of Energy, and has recently been designated as the lead Department spokesman on nonproliferation matters.

He will be accompanied this afternoon by Dr. Marvin Moss, who is the Associate Director for Nuclear Nonproliferation within the Office of Energy Research of the Department of Energy.

Dr. Cunningham, we are looking forward to hearing your comments on INFCE and, in particular, on the recently released final NASAP report.

You may begin at this time.

Dr. Cunningham. Thank you very much, Madam Chairman.

I am also accompanied by Ambassador Handyside, Director of the Office of Nuclear Affairs in DOE's Office of International Affairs.

STATEMENT OF DR. GEORGE CUNNINGHAM

Dr. Cunningham. It is a pleasure to appear before this committee again and, in particular, to discuss the international nuclear fuel cycle evaluation and also the recently released report, "Nonproliferation Alternative System Assessment Program."

The Department of Energy, in close cooperation with the Department of State and the Arms Control and Disarmament Agency, has played a major role in nonproliferation efforts.

As you have indicated, within the Department of Energy, I have recently been designated as the Principal Assistant Secretary to speak on nonproliferation matters.

We, in the Department of Energy, consider as a major function, the provision of technical support to the Department of State in their negotiations on nonproliferation matters.

At the present time, we are at an important juncture in the nonproliferation efforts initiated by the Carter administration 3 years ago. The extensive studies performed by INFCE and NASAP have been completed, and the Department of Energy has begun to implement technical programs in support of some of the findings of these studies.

In the months ahead, we will be working intensively with other countries to assure that nuclear power continues to play an important role in meeting global energy needs under an improved nonproliferation regime.

Proliferation is a complex and difficult issue requiring consideration of a wide range of institutional and technical approaches, no one of which, by itself, can be expected to offer an adequate solution.

Both INFCE and NASAP studied the question of the proliferation relevance of the fuel cycle intensively, and concluded that this problem, while certainly not the whole of the proliferation issue, exists and must be taken into account in nuclear energy program planning.

I would like to submit a more detailed written statement for the record and abbreviate some of my remarks to stay within the time constraints.

Mrs. BOUQUARD. Your complete statement will be made part of the record.

Dr. CUNNINGHAM. The international nuclear fuel cycle evaluation, INFCE, was organized at the Plenary Conference held in Washington, D.C., on October 19–21, 1977.

Eventually over 60 nations and four international organizations participated in this unprecedented international effort.

It should be stressed that INFCE was a technical and analytical study and not a negotiation. Furthermore, the evaluation was to be carried out in a spirit of objectivity, with mutual respect for each country's choices and decisions in this field, without jeopardizing their respective fuel cycle policies or international cooperation agreements and contracts for the peaceful use of nuclear energy, provided that agreed safeguards measures are applied. The results have been transmitted to governments for their consideration in developing their nuclear energy policies and in international discussions concerning nuclear energy cooperation and related controls and safeguards. Participants are not committed to INFCE's results.

One of the most important results of the INFCE process was the consensus by INFCE participants that proliferation of nuclear weapons capability is a serious problem that deserves attention in the planning and implementation of nuclear programs in the future.

There is a general agreement that there are no technical or institutional "fixes" to current or alternative nuclear fuel cycles that will eliminate the problem of proliferation.

Rather, there exists a range of technical choices within a fuel cycle as well as alternative institutional arrangements that offer some potential for making the problem more manageable.

There was also general agreement that the economic benefits of recycle of plutonium in thermal reactors are marginal, although some countries see it as a potential contribution to energy independence.

As I mentioned, we are still assessing the INFCE results in terms of their specific implications for DOE program choices. However, I would like to mention briefly some of the key results, many of which are encouraging to U.S. hopes for restraint and caution in certain sensitive nuclear activities. These factors do not represent the total of the INFCE results, but they represent a balanced selection of results which are particularly applicable to the U.S. program.

Application of effective and improved international safeguards is an essential feature of the operation of nuclear fuel cycle facilities; safeguards provisions should be incorporated at the very earliest stages of plant design.

I might add here that no country objected to the idea of strengthening the international safeguards.

Now, potential improvements in once-through technology could lead to savings of 10–15 percent in uranium utilization for LWR's without undue economic or safety consequences. This could be demonstrated within the next decade if the necessary development programs prove successful.

As you know, we do have some of those necessary development programs proceeding in the U.S. program.

Next, worldwide uranium resources are not well known and an international effort to assess resources should be expanded.

I would add here that the U.S. resources are probably the best known of all of those in the world, even though we, ourselves, continue to support the idea of an extended uranium exploration program in this country. I would also say that little or no information from the Communists or the centrally planned economies was made available to INFCE. The uranium resource information that is available is primarily from the non-Communist world.

The costs of a national breeder program will be high. Breeder development and deployment is not likely to be economically attractive to countries having a need for few nuclear powerplants. Timing and need are highly dependent on the specific uranium supply and nuclear power demand situation of individual countries.

Reduced enrichment for research reactor fuel is also considered a valuable means for increasing proliferation resistance.

Projected worldwide demand for enrichment services through the mid-1990's can be met by existing and planned facilities. Additional enrichment capability should be developed only in response to the needs of a competitive market. This is particularly desirable from the perspective of nonproliferation. Limiting enrichment and sensitive fuel recycle facilities to a few large facilities has economic and nonproliferation advantages.

Greater assurance of nuclear fuel supply can contribute to nonproliferation objectives by reducing the pressures for worldwide spread of enrichment and reprocessing facilities.

International spent fuel management could be of valuable assistance to some countries in the economic and management aspects of spent fuel storage.

Proliferation concerns associated with separated plutonium must be addressed through improved safeguards and other technical and institutional measures, possibly including an international plutonium storage regime.

Through the International Atomic Energy Agency there is a very active study that is going on regarding proceeding with an international plutonium storage regime.

Mrs. Bouquard. Could I ask you a question at this time, Dr. Cunningham?

Dr. Cunningham. Yes.

Mrs. Bouquard. Could you elaborate on that?

Dr. Cunningham. Yes. In general, the idea here is that plutonium which is available for use by the various countries throughout the world, should be made available in terms of the need for the real existing planned nuclear reactor development programs. In cases where plutonium is produced more as a byproduct or is not directly needed in conjunction with planned research and development and production of the nuclear plants, that plutonium would be considered as excess plutonium and would be placed under international controls. That's the idea for the international plutonium storage regime. A very active study is taking place under the auspices of the International Atomic Energy Agency. There have been four meetings so far by an international committee to try to work out the approach and details for handling what is considered as excess plutonium under an international storage regime.

Mrs. BOUQUARD. Do you think that this is realistic, Dr. Cunningham?

Dr. CUNNINGHAM. Yes. I think it is realistic. This is in the sense that different countries have different ideas on how the controls should be placed, particularly in regard to how you judge which plutonium should go into the storage regime and the controls under which plutonium should be removed or the conditions under which the plutonium can be removed. There is a great deal of discussion on that particular point.

The generally accepted idea is that, when there is excess plutonium, it should be under international control and safeguards.

Mrs. BOUQUARD. Thank you.

Dr. CUNNINGHAM. Yes.

Mrs. BOUQUARD.. Please go ahead.

Dr. CUNNINGHAM. In the near term, contributions to reducing proliferation risks will be of an evolutionary nature in existing systems. No new or advanced systems can contribute to a significant degree in the near future. This is primarily because of the very long leadtimes required in the nuclear industry to put new or advanced systems in place to a degree where they can make a significant contribution.

Thorium based fuel cycles overall offer no significant nonproliferation advantages over uranium-plutonium cycles. However, thorium may, in the long term, provide a significant addition to the resource base in some countries. This will add to the fuel availability question in terms of the technical aspects of the fuel cycle itself. We could find no particular advantage for the utilization of the thorium cycle.

Finally, the safe management of nuclear wastes is not a justification for reprocessing of spent fuel.

In general, the committee found that both spent fuel and the waste from reprocessed materials could be safely stored both on a temporary and permanent basis.

The INFCE reports are clearly subject to a variety of different interpretations, particularly regarding some of the more contentious nuclear policy issues. This situation is inevitable in view of the fact that INFCE, as a technical assessment with no negotiating mandate, could not have hoped to resolve these issues.

The findings were arrived at through a process of technical consensus. On particularly complex or politically sensitive questions, these findings necessarily reflect different perspectives, and may not be entirely satisfactory to any single participant.

Therefore, certain statements read in isolation may appear to validate or rebut specific national policies, but the reports as a whole do not.

I might add, furthermore, that in an examination of the technical reports themselves, one would find that there is generally very good technical agreement with regard to the technical points discussed. In other words, there was very little argument as long as the question was strictly technical and could be judged on the technical merits.

In those areas where there were political concerns, there was considerably more difficulty in reaching consensus or agreement.

INFCE stressed that no one fuel cycle strategy is appropriate for all countries, and that program choices are subject to a great many economic, technological and resource considerations which vary widely among countries.

On a number of points, such as the high cost of breeder development programs, the marginal economics of thermal recycle, and the need for improved safeguards, the United States believes that the INFCE reports point in the direction of caution and restraint in moves toward sensitive technologies.

On the other hand, INFCE also strongly presented the potential advantages of breeders for advanced countries, and our allies in Europe and Japan have understandably emphasized these findings as supportive of their programs.

Next, I'd like to discuss the NASAP study. Here, I would like to summarize the program which has been underway at the Department of Energy for several years.

The NASAP final report was released to the Department of Energy just this week, on June 2. I would like to emphasize that NASAP per se, is not a statement of U.S. policy in all areas. It is an effort which was directed at providing technical support to U.S. participation in INFCE.

The nuclear systems examined by NASAP ranged from those currently in use throughout the world to others that have not yet progressed beyond the conceptual stage. They were examined not only from the standpoint of proliferation risks, but also in terms of their efficiency of resource use, cost and safety and environmental characteristics. These elements, along with the commitments that would have to be undertaken in performing the research, development and demonstration of the systems, were summarized in an assessment of commercial potential.

The NASAP report concludes that all nuclear fuel cycles entail varying degress of proliferation risk. However, the once-through light water reactor fuel cycle involves no directly weapons-usable material and is a more proliferation-resistant fuel cycle than those which use highly enriched uranium or plutonium.

NASAP found, as did INFCE, that nuclear power systems can be made more proliferation-resistant and that proliferation risk in future fuel cycle development can be reduced by the introduction of combinations of technical and institutional measures. Technical measures alone will not be sufficient.

A major theme of the NASAP report is that U.S. policy should continue to be directed toward establishing a nonproliferation regime which recognizes the need for security of energy supply.

To enhance security of supply and nonproliferation effectiveness, certain existing international arrangements must be improved and new ones established on a cooperative basis. In this area, NASAP made the following major observations. The planned expansion of domestic enrichment capacity should continue, as should the programs to develop more proliferation resistant technology and develop advanced technology to provide more economical enrichment services; improved institutional arrangements for spent fuel storage and disposal services should be pursued. The United States should continue to urge others to refrain from developing reprocessing capability until it is clearly needed. However, where reprocessing occurs, proliferation risk would be reduced if: sensitive services were to be provided by a few large facilities; safeguards were to be strengthened at all sensitive areas of the fuel cycle; services were to be supplied based on fast-breeder and advanced reactor R. & D. needs where there exist both economic and technical justifications; and if an international plutonium-management regime was to operate under effective and credible nonproliferation norms.

The NASAP and INFCE have confirmed that nuclear fuel cycle developments can affect proliferation risks and that this fact must be given adequate weight in national and international nuclear energy planning. It is important that all agencies of the U.S. Government continue their efforts to minimize those risks. It should be noted that DOE, in carrying out this policy, is aggressively pursuing programs in a number of important areas including the conversion of highly enriched uranium-fueled research reactors to lower enrichments, improvements in LWR fuel utilization efficiency, improved international safeguards and continued uranium exploration.

Madam Chairman, this concludes my prepared remarks. Either my colleagues or I will be happy to answer any questions that you may have at this time.

[The prepared statement and additional questions and answers asked of Dr. Cunningham and Dr. Moss follow:]

STATEMENT OF
GEORGE W. CUNNINGHAM
ASSISTANT SECRETARY
FOR NUCLEAR ENERGY
U.S. DEPARTMENT OF ENERGY

BEFORE THE
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY

JUNE 5, 1980

Mr. Chairman and Members of the Committee, it is a pleasure to appear before you to discuss the International Nuclear Fuel Cycle Evaluation (INFCE) and the Nonproliferation Alternative Systems Assessment Program (NASAP). I am accompanied today by Dr. Marvin K. Moss, Associate Director for Nuclear Nonproliferation in the Office of Energy Research.

The Department of Energy, in close cooperation with the Department of State (DOS) and the Arms Control and Disarmament Agency (ACDA), has played a major role in nonproliferation efforts. Within DOE, I have recently been designated as the principal Assistant Secretary to speak on nonproliferation matters. Programs concerned with research and development on proliferation-resistant fuel cycle technologies are conducted primarily by my Office. The Office of Nuclear Affairs, under the Assistant Secretary for International Affairs, cooperates closely with State and ACDA on nonproliferation policy matters and has important delegated responsibilities, along with State, in implementing the Nuclear Nonproliferation Act (NNPA). These responsibilities include tasks such as negotiating agreements for cooperation, and processing "subsequent arrangements." The Office of Nuclear Nonproliferation, under the Director of Energy Research, also plays an important role across a wide range of nonproliferation programs and policy issues, and administers several programs dealing with nonproliferation. The National Uranium Resources Evaluation (NURE) program is in the Office of Resource Applications, which is also responsible for uranium enrichment services. Technical safeguards issues, physical security, export controls, and nonproliferation intelligence are located in the Office of Defense Programs.

We are at an important juncture in the nonproliferation efforts initiated by the Carter Administration three years ago. The extensive studies performed by INFCE and NASAP have been completed, and although their full implications are still being assessed, the Department of Energy has begun to implement technical programs in support of some of the findings of these studies. In the months ahead, we will be working intensively with other countries to assure that nuclear power continues to play an important role in meeting global energy needs under an improved nonproliferation regime. Proliferation is, as we all know, a complex and difficult issue requiring consideration of a wide range of institutional and technical approaches, no one of which, by itself, can be expected to offer an adequate solution.

There are of course a number of potential paths to nuclear proliferation. The present Administration has fully recognized the mutiple and complex dimensions of the proliferation problem. The present policy reflects a concern that the relative risks of proliferation associated with the nuclear power fuel cycle would increase substantially if direct access to weapons usable material became widespread. Such concern was prompted in particular by the prospect of the premature spread of sensitive fuel cycle facilities to additional countries.

Both INFCE and NASAP studied the question of the proliferation-relevance of the fuel cycle intensively, and concluded that this problem--while certainly not the whole of the proliferation issue--exists and must be taken into account in nuclear energy program planning.

Domestically, the U.S. decision to defer commercialization of reprocessing and the breeder was based on both economic and non-proliferation grounds. In light of the projected nuclear power demand and uranium resource availability, it was determined that commercialization of the breeder could be deferred. At the same time, since the economics of thermal recycle are not compelling, the timing of reprocessing should be keyed to breeder program needs.

The potential risks associated with a premature and widespread transition to reprocessing and plutonium recycle led the U.S. to urge other countries to exercise similar restraint and caution in moves toward the development of sensitive fuel cycles. U.S. deferral of reprocessing was necessary in order to emphasize the seriousness of our concerns.

It is of course difficult to assess the precise effect of our initiatives on others. The reprocessing and breeder programs of our industrial allies are based on their own assessment of the energy and economic realities facing them. In some cases, these assessments obviously differ from our own. However, even those countries which have reprocessing programs now should have greater appreciation of the need to consider proliferation risks in their nuclear fuel cycle and export policies.

INFCE

The International Nuclear Fuel Cycle Evaluation (INFCE) was organized at the Plenary Conference held in Washington, DC, on 19-21 October 1977. Eventually over 60 nations and four international organizations participated in this unprecedented international effort. In the communique issued by the Conference, the participants

were conscious of the urgent need to meet the world's energy requirements and that nuclear energy for peaceful purposes should be made widely available to that end;

were convinced that effective measures can and should be taken at the national level and through international agreements to minimize the danger of proliferation of nuclear weapons without jeopardizing energy supplies or the development of nuclear energy for peaceful purposes; and

recognized that special consideration should be given to the specific needs of and conditions in developing countries.

It should be stressed that INFCE was a technical and analytical study and not a negotiation. Furthermore, the evaluation was to be carried out in a spirit of objectivity, with mutual respect for each country's choices and decisions in this field, without jeopardizing their respective fuel cycle policies or international co-operation agreements and contracts for the peaceful use of nuclear energy, provided that agreed safeguards measures are applied. The results have been transmitted to governments for their consideration in developing their nuclear energy policies and in international discussions concerning nuclear energy cooperation and related controls and safeguards. Participants are not committed to INFCE's results.

One of the most important results of the INFCE process was the consensus by INFCE participants that proliferation of nuclear weapons capability is a serious problem that deserves attention in the planning and implementation of nuclear programs in the future. There now exists a better technical understanding of the nature of proliferation risks in the fuel cycle. There is general agreement that there are no technical or institutional "fixes" to current or alternative nuclear fuel cycles that will eliminate the problem of proliferation. Rather, there exists a range of technical choices within a fuel cycle as well as alternative institutional arrangements that offer some potential for making the problem more manageable.

There was also general agreement that the economic benefits of recycle of plutonium in thermal reactors are marginal although some countries see it as a potential contribution to energy independence.

As I mentioned, we are still assessing the INFCE results in terms of their specific implications for DOE program choices. However, I would like to mention briefly some of the key results , many of which are encouraging to U.S. hopes for restraint and caution in certain sensitive nuclear activities.

1. Application of effective and improved international safeguards is an essential feature of the operation of nuclear fuel cycle facilities; safeguards provisions should be incorporated at the very earliest stages of plant design.

2. Potential improvements in once-through technology could lead to savings of 10-15 percent in uranium utilization for LWRs without undue economic or safety consequences; this could be demonstrated within the next decade if the necessary development programs prove successful.

3. World-wide uranium resources are not well known and an international effort to assess resources should be expanded.

4. The costs of a national breeder program will be high. Breeder development and deployment is not likely to be economically attractive to countries having a need for few nuclear power plants. Timing and need are highly dependent on the specific uranium supply and nuclear power demand situation of individual countries.

5. Reduced enrichment for research reactor fuel is considered a valuable means for increasing proliferation resistance.

6. Projected world-wide demand for enrichment services through the mid-1990's can be met by existing and planned facilities. Additional enrichment capability should be developed only in response to the needs of a competitive market; this is particularly desirable from the perspective of nonproliferation. Limiting enrichment and sensitive fuel recycle facilities to a few large facilities has economic and nonproliferation advantages.

7. Greater assurance of nuclear fuel supply can contribute to nonproliferation objectives by reducing the pressures for world-wide spread of enrichment and reprocessing facilities.

8. International spent fuel management could be of valuable assistance to some countries in the economic and management aspects of spent fuel storage.

9. Proliferation concerns associated with separated plutonium must be addressed through improved safeguards and other technical and institutional measures, possibly including an international plutonium storage regime.

10. In the near term, contributions to reducing proliferation risks will be of an evolutionary nature in existing systems. No new or advanced systems can contribute to a significant degree in the near future.

11. Thorium based fuel cycles overall offer no significant nonproliferation advantages over uranium-plutonium cycles. However, thorium may, in the long-term, provide a significant addition to the resource base in some countries.

12. The safe management of nuclear wastes is not a justification for reprocessing of spent fuel.

On the issue of projected nuclear demand, there will be a need for periodic revision of the estimates developed in INFCE. These estimates were prepared over two years ago and projections for nuclear power growth and associated expansion of sensitive facilities generally have been reduced.

The INFCE reports are clearly subject to a variety of different interpretations, particularly regarding some of the more contentious nuclear policy issues. This situation is inevitable in view of the fact that INFCE, as a technical assessment with no negotiating mandate, could not have hoped to resolve these issues. The findings were arrived at through a process of technical consensus. On particularly complex or politically sensitive questions, these findings necessarily reflect different perspectives, and may not be entirely satisfactory to any single participant. Therefore, certain statements read in isolation may appear to validate or rebut specific national policies, but the reports as a whole do not.

Viewed in terms of its mandate and the difficult problems it faced, the U.S. considers INFCE to have been a successful and valuable undertaking. It made a significant contribution in clarifying the economic and technical basis on which policy decisions partially rest, and most importantly, in assessing the proliferation risks in various steps in the fuel cycle.

INFCE stressed that no one fuel cycle strategy is appropriate for all countries, and that program choices are subject to a great many economic, technological, and resource considerations which vary widely among countries. On a number of points--such as high cost of breeder development programs, the marginal economics of thermal recycle, and the need for improved safeguards--the U.S. believes the INFCE reports point in the direction of caution and restraint in moves toward sensitive technologies. On the other hand, INFCE also strongly presented the potential advantages of breeders for advanced countries, and our allies in Europe and Japan have understandably emphasized these findings as supportive of their programs.

NASAP

Mr. Chairman, I would also like to summarize the Nonproliferation Alternative Systems Assessment Program (NASAP) which has been under way at DOE for several years. This program, which has important nonproliferation ramifications, is now drawing to a close. The NASAP final report, Nuclear Proliferation and Civilian Nuclear Power, was released by the Department of Energy just this week, on June 2, 1980. I would like to emphasize that NASAP, per se, is not a statement of U.S. policy in all areas. It is an effort which was directed at providing technical support to U.S. participation in INFCE.

The nuclear systems examined by NASAP ranged from those currently in use throughout the world to others that have not yet progressed beyond the conceptual stage. They were examined not only from the standpoint of proliferation risks, but also in terms of their efficiency of resource use, cost, and safety and environmental characteristics. These elements, along with the commitments that would have to be undertaken in performing the research, development, and demonstration of the systems were summarized in an assessment of commercial potential.

The NASAP report concludes that all nuclear fuel cycles entail varying degrees of proliferation risk. However, the once-through light-water reactor fuel cycle involves no directly weapons-usable material and is a more proliferation-resistant fuel cycle than those which use highly enriched uranium or plutonium.

NASAP found, as did INFCE, that nuclear power systems can be made more proliferation-resistant and that proliferation risk in future fuel cycle development can be reduced by the introduction of combinations of technical and institutional measures; technical measures alone will not be sufficient.

A major theme of the NASAP report is that U.S. policy should continue to be directed toward establishing a nonproliferation regime which recognizes the need for security of energy supply.

To enhance security of supply and nonproliferation effectiveness, certain existing international arrangements must be improved and new ones established on a cooperative basis. In this area, NASAP made the following major observations: planned expansion of domestic enrichment capacity should continue, as should the programs to develop more proliferation-resistant technology and to develop advanced technology to provide more economical enrichment services; improved institutional arrangements for spent fuel storage and disposal services should be pursued; the U.S. should continue to urge others to refrain from developing reprocessing capability until it is clearly needed. However, where reprocessing occurs, proliferation risk would be reduced if: sensitive services were to be provided by a few large facilities; safeguards were to be strengthened at all sensitive areas of the fuel cycle; services were to be supplied based on fast-breeder and advanced reactor R&D needs where there exist both economic and technical justifications; and any international plutonium-management regime were to operate under effective and credible nonproliferation norms.

The NASAP and INFCE studies have confirmed that nuclear fuel cycle developments can affect proliferation risks and that this fact must be given adequate weight in national and international nuclear energy planning. It is important that all agencies of the U.S. Government continue their efforts to minimize those risks. It should be noted that DOE, in carrying out this policy is aggressively pursuing programs in a number of important areas including: the conversion of highly enriched uranium-fueled research reactors to lower enrichments, improvements in LWR fuel utilization efficiency, improved international safeguards, and continued uranium exploration.

In addition, DOE is actively involved in a number of international activities which INFCE identified as meriting further exploration and effort. In the area of international spent fuel cooperation, a feasibility study on the prospects for a Pacific Basin storage facility is currently under negotiation with Japan. Another study, which is being conducted under the auspices of the International Atomic Energy Agency, is exploring ways in which international cooperation in spent fuel management might assist countries in meeting the needs of their nuclear energy programs. DOE is also participating in an IAEA study examining possible schemes for the establishment of an effective international plutonium storage system. In addition, we are continuing to cooperate with other countries in the International Uranium Resources Evaluation Project to identify global uranium deposits.

Mr. Chairman, this concludes my prepared remarks. I shall be happy to answer any questions you may have at this time.

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June 10, 1980

Dr. George Cunningham
Assistant Secretary for
  Nuclear Energy
U. S. Department of Energy
Washington, D. C. 20585

Dear Dr. Cunningham:

Thank you once again for appearing before the Subcommittee on Energy Research and Production during our June 5 hearing on the International Nuclear Fuel Cycle Evaluation study and the implications for future nuclear energy research and development. Please extend my appreciation to Dr. Moss for his participation. We found your testimony useful, and we sincerely appreciate you sharing your experience with us.

During the hearing we indicated that the Subcommittee might request some additional information in the form of further questions. Having reviewed the testimony received at the hearing, we find that additional information would be very helpful. Accordingly, we would appreciate your providing, for the record, responses to the enclosed questions. For the same reasons that we requested Dr. Moss' presence at the hearing, we request that he respond to the enclosed questions directed toward him.

Your prompt reply would be most appreciated. Thank you for your cooperation on this matter.

Sincerely,

Mike McCormack

MIKE McCORMACK, Chairman
Subcommittee on Energy
Research and Production

MM/Cwm

Enclosures

QUESTIONS FOR
Dr. George Cunningham
following
INFCE HEARING
June 5, 1980

1. What efforts are under way to develop the future DOE nuclear R&D programs in the light of INFCE and NASAP?

2. Is DOE proceeding on the basis of the findings of INFCE & NASAP or is planning being dictated by Administration policies in existence for some time now?

3. Would DOE be satisfied with a compromise nonproliferation policy which endorses reprocessing for breeder RD&D, while avoiding or deferring it for LWR recycle or waste management?

4. At the time the nonproliferation policy was announced and shortly thereafter, the Administration sought to gain acceptance of its view by offering a number of inducements to those nations adhering to U.S. nonproliferation objectives. All of these inducements seemingly have been delayed. Could you give us a status report on some of these programs, such as U. S. storage of foreign generated spent fuel? The creation of an International Nuclear Fuel Bank? The Portsmouth add-on?

5. This Administration has made conservation the key to its energy program. Yet it continues to ignore the immense amounts of neergy contained in spent fuel. Granted there are risks with reprocessing, but there are also health risks from other forms of conservation such as insulating one's house. Have such risks even been compared? Or are we treating each in isolation?

6. The post-INFCE judgment of the Administration on spent fuel storage was apparently expressed by Ambassador Smith in his statement on the INFCE Final Plenary Conference when he observed "spent fuel can be safely stored on an interim or long-term basis, and permanent disposal without reprocessing appears to be a realistic option for either economic or nonproliferation reasons." Isn't it true that thermal reactor spent fuel from the once-through fuel cycle following the loss of its initial radiation barrier is the only fuel cycle with a residual proliferation risk? Is the Administration convinced that spent fuel reprocessing would not contribute to better long-term proliferation resistance for spent thermal reactor fuel?

7. Isn't it true that INFCE concluded that in terms of environmental impact of nuclear waste management, the once-through thermal reactor fuel cycle is the least favorable and the breeder reactor cycle the most favorable? What is the Administration's view as to the effect this conclusion should have on current U. S. reprocessing and breeder policy?

8. INFCE found that certain technical steps, such as coprocessing, would tend to increase diversion resistance but that considerable development work would be required before they could be introduced on a commercial scale. In your judgment, how could the U. S. assist in proving the technical and economic feasibility of these more diversion-resistant technologies, particularly through the use of programs or facilities which already exist or could be made available in the near future?

9. In estimating the sufficiency of uranium reserves, one is confronted with estimates of almost 100 percent difference in the number of light water reactors which will be on line in the year 2000. What is the latest DOE projection? How many reactors could be on line if a future Administration would make it possible to construct and operate enough nuclear reactors to meet reasonable projections of electrical energy demand by 2000, along with maximum development of coal and renewable sources? What would be the impact of this on U. S. uranium reserves? On domestic enrichment capacity? On the future need for reprocessing and the breeder?

10. Given that many nations argue for the breeder because they see scarce world uranium supplies, and also see the U. S. as "guzzling" available supplies through inefficient nuclear fuel cycles, what is DOE doing to support the U. S. argument that there, indeed, is enough uranium and how does this square with the drastic cutback in the NURE program?

11. It must be evident to the Administration that there are basically no technical secrets of any significance remaining in such fields as nuclear fuel reprocessing. The fact that so many other nations of the world have developed capability in reprocessing without benefit of U. S. transfer of technology is a reasonable demonstration of that statement. On what basis can the U. S. pretend to impose a unilateral position regarding reprocessing on such nations as Japan who are dependent upon imported fuel to the extent that they must seek and develop all alternatives?

12. A recent NEW YORK TIMES noted that France is proceeding rapidly with the Super-Phoenix reactor to replace its reliance on foreign oil. While the Administration has opposed the construction of the Clinch River Breeder Reactor for various reasons, the latest seems to be that given the availability of alternative fuels, the U. S. doesn't need to move quickly in this area. The unfortunate fact is that the development of domestic coal reserves has been a national priority for seven years now, yet coal development has yet to significantly expand. Are such considerations taken into account in your projections on the need for the breeder?

13. The U. S. position with respect to fast breeders appears to be one of recognition of the ultimate need for such energy sources but a serious disagreement as to the timing for the commercial introduction of this technology.

    -- What information has been developed by the Administration to support this contention that nothing more need be done at this time other than some cooperative research and development.

    -- Have any studies been undertaken which will clearly demonstrate that there is sufficient time between now and the year 2010 to accommodate the complex, technically demanding, institutionally uncertain steps that must be taken before commercial feasibility can be established?

QUESTIONS FOR
Dr. Marvin Moss
following
INFCE HEARING
June 5, 1980

There are a number of questions we would like to ask Dr. Moss who we understand has been the principal policy formulator for DOE for nonproliferation matters, and also who is the principal liaison official between DOE and the other agencies.

1. What is the specific logical connection between the U. S. domestic nuclear program (that is the breeder reprocessing, etc.) and our nonproliferation strategy?

2. Our allies and the developing nations are accusing us of being nuclear wastrels. Just as we have burdened the world oil supplies -- we will overtax the world's uranium supplies -- unless we move ultimately to breeder reactors. There will, indeed, be little uranium available for the deployment of converter reactor systems in the developing nations. Not only is our current policy one of self-denial but it is also a policy of denial to those nations who seek a higher standard of living. What are your views on this perception?

3. Has the U. S. policy of "self-denial" regarding reprocessing and the breeder been effective in furthering U. S. nonproliferation objectives?

4. Civilian nuclear power systems are but one of the many possible routes to weapons proliferation. Would you comment on why we are turning our back on an essentially inexhaustible energy supply in the U. S. when: (a) the connection between our domestic actions and our nonproliferation objectives is so weak, and (b) when, indeed, there are easier and more preferred routes to weapons capability than by diversion of the civilian nuclear cycle?

5. In our view, the policy of denial and of empty preachments has failed. A more positive approach would be for the U. S. to move swiftly to breeder deployment than to offer guarantees in good faith for enrichment uranium supply to non-weapons states. If they agree to appropriate safeguards and to return the spent fuel to the U. S., would you accept this approach? If not, why?

6. Since President Carter's April 7, 1977 announcement of U. S. "Nuclear Power Policy", including indefinite deferral of commercial reprocessing and thermal recycle and restructuring of the U. S. breeder program, can you identify any specific case in which another nation has voluntarily altered its plans in these areas as a result of our policy?

7. Statements by at least eight participants at the final plenary session of INFCE called for the further development and improvement of current safeguard methods and technologies (Australia, Denmark, Canada, Egypt, Japan, Netherlands, Sweden, Euratom).

   As the leading nonproliferation proponent, it would seem that our domestic safeguard R&D programs would reflect this importance. How do you explain the GAO finding (March 18, 1980) that "the Administration's policy has hampered research and development of ways to safeguard against the diversion of nuclear material"?

Dr. Marvin Moss
Questions
Page Two

8. Recently, Administration spokesmen (e.g., Kitty Schirmer) have begun calling CRBR both premature and outmoded. This seems to me to be contradictory. Would you please elaborate?

9. Do you see any prospect for reaching new agreements with Euratom, Japan and other important nuclear countries until we are willing to specify the circumstances under which they can expect reprocessing approval?

10. Would the U. S. position in international nuclear matters be stronger or weaker if we were constructing large-scale breeder prototype?

    What about operating an industrial scale reprocessing facility?

Department of Energy
Washington, D.C. 20585

July 8, 1980

Dear Mr. Lanes:

Attached you will find answers to questions submitted to George W. Cunningham, Assistant Secretary for Nuclear Energy, of the Department of Energy, for the hearing before the Committee on Science and Technology, Subcommittee on Energy Research and Production on June 5, 1980.

If you have any questions please do not hesitate to contact me directly on 252-5777.

Sincerely,

Frank R. Pagnotta

Frank R. Pagnotta
Director
Office of The Secretary

Mr. Steven Lanes
Staff Director
Committee on Science and
Technology
Subcommittee on Energy
Research and Production
Room B-374, RHOB
Washington, D.C. 20515

Department of Energy
Washington, D.C. 20585

Honorable Mike McCormack
Chairman, Committee on Energy
Research and Production
Committee on Science and Technology
House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

I am pleased to provide additional information for the record for the June 5, 1980, Hearing on the International Nuclear Fuel Cycle Evaluation and the Nonproliferation Alternative Systems Assessment Program. Also enclosed are responses to the questions you posed to Dr. Moss.

As you appreciate, the responsibility for policy direction in the Department of Energy has always resided at the Secretarial level. Recently, I have been designated as the principal Assistant Secretary to speak on nonproliferation matters. Several other offices besides Nuclear Energy and Energy Research are centrally involved in nonproliferation policy and implementation. In particular, International Affairs plays a major role in nonproliferation policy, collaborating closely with State and ACDA on a wide variety of nonproliferaton issues and in implementing important aspects of the Nuclear Nonproliferation Act that have been assigned to DOE. Thus, we view the DOE participation in nuclear and nonproliferation matters to be a team affair in which every effort is made to provide DOE management with an appreciation of differing options, perspectives, and viewpoints.

Accordingly, the responses that are enclosed reflect our collective inputs rather than the personal views of one or two individuals.

Sincerely,

George W. Cunningham
Assistant Secretary
for Nuclear Energy

2 Enclosures

RESPONSES TO ADDITIONAL QUESTIONS
REQUESTED OF
DR. GEORGE W. CUNNINGHAM

No. 1

Q. What efforts are under way to develop the future DOE nuclear R&D programs in the light of INFCE and NASAP?

A. Although the full implications of the INFCE and NASAP studies are still being assessed, the Department of Energy is already beginning to implement technical programs in support of some of the findings of these studies. For example, in DOE's FY 81 budget request, additional emphasis has been given to programs for the improvement of uranium utilization in light-water reactors. Within 10 years, a 15% improvement in uranium utilization should be achievable based primarily on the development of fuels and fuel cladding that can attain significantly higher burnups than those currently in use and also on changes in fuel management. This DOE program stresses industry participation and cooperative international efforts as well. Further additional uranium utilization improvements of up to 15% might also be possible by the year 2000 if a variety of currently planned developments are carried out successfully. These will be investigated to determine their technical and economic feasibility.

DOE's Reduced Enrichment Research and Test Reactors Program (RERTR) has provided an important technological base on which the U.S. has been able to gain world-wide acceptance of the idea that a large proportion of the research and test reactors around the world can be operated with fuel of a lower enrichment without sacrificing safety margins, fuel reliability and reactor performance or increasing operating costs by more than a marginal amount. Prototypical fuel is now being produced. After two to four years of prooftesting and safety analysis, fuel should be available for conversion of research reactors to lower enriched uranium.

Since 1974, the U.S. has conducted the National Uranium Resource Evaluation (NURE), a systematic effort to develop the data needed to identify geological features that suggest the presence of uranium in locations in the United States. This program should be completed by the mid-1980's. Both INFCE and NASAP pointed out the need to cooperate with other countries in identifying additional global uranium deposits. We are also supporting the International Uranium Resources Evaluation Project (IUREP) and funding for that is contained in the DOE FY 1981 budget request.

INFCE suggested that proliferation concerns associated with separated plutonium be addressed through improved safeguards and other technical and institutional measures, possibly including an international plutonium storage regime. Through the active involvement of DOE, ACDA and the State Department, the U.S. is continuing its strong support of the international safeguard system. Safeguards research and development performed by IAEA is supported directly by the U.S. through funds in the State Department budget. These funds are part of the U.S. voluntary contribution to the IAEA and DOE plays the major role in formulating and administering the technical aspects of the program.

No. 2

Q. Is DOE proceeding on the basis of the findings of INFCE & NASAP or is planning being dictated by Administration policies in existence for some time now?

A. While there was considerable agreement among INFCE particpants that the way the nuclear fuel cycle is organized can affect the proliferation related risks of nuclear power, the participants in INFCE do not all necessarily share a common view on desired future directions. This is reflective, in part, of differing energy demands and differing degrees of dependence on imported fuels. The results have been transmitted to governments for their consideration in developing their nuclear energy energy policies and in international discussions concerning nuclear energy cooperation and related controls and safeguards. From the U.S. perspective, some of the more important findings of INFCE include:

- the need for improved safeguards at all sensitive areas of the fuel cycle,
- safe management of nuclear wastes does not require reprocessing of spent nuclear fuel,
- the economic benefits of the recycle of plutonium in thermal reactors are marginal.
- fuel cycles involving access to weapons useable material offer greater proliferation risks than those which do not.

In addition, DOE is proceeding with its nuclear R&D programs on the basis of the findings of INFCE, as stated above, and of NASAP as detailed in the response to question #1. The research and development program recommendations of NASAP, which can be found in Table 1 of the Executive Summary of the report reproduced here, have served to reinforce current Administration policies.

TABLE 1. RESEARCH AND DEVELOPMENT PROGRAM RECOMMENDATIONS

PROGRAM	TARGET
Light-Water Reactor Fuel-Utilization Improvements:	
• High burnup, and operational and fuel-management changes	Commercial implementation by 1990
• Additional high burnup and other fuel-design changes	Commercial implementation by 2000
• Longer-term nonretrofittable improvements	Identify initial attractive candidates by mid-1980; commercial capability after 2000
Reduced Enrichment of Research Reactor Fuel	Demonstrate 20-45% enriched fuel by 1982; demonstrate <20% enriched fuel by 1984
Liquid-Metal Fast Breeder Reactor	Continue development so that it could be commercially available if and when needed (possibly 2010-2020)
Advanced Isotope Separation	Demonstrate technical and economic performance of a process by 1990-1995
Light-Water Breeder Reactor	Continue development and complete proof of breeding demonstration in Shippingport Atomic Power Station by 1985 or 1986
Proliferation-Resistance Engineering of Reprocessing	Demonstrate in breeder program pilot fuel-cycle facilities
High-Temperature Gas-Cooled Reactor	Assess unique markets, such as those for process heat and usability at water-poor sites
Fast Mixed-Spectrum Reactor	Investigate high-burnup fuel technology
National Uranium Resource Evaluation	Complete program by 1985. Continue research and development in discovery and extraction methods
Technology Support for IAEA Safeguards on: • Enrichment plants • Interim spent-fuel storage • Spent-fuel disposal repository • Reprocessing plants • Plutonium storage • Mixed-oxide fabrication plants • Transportation	Continued improvement in surveillance, containment, and material accountancy

No. 3

Q. Would DOE be satisfied with a compromise nonproliferation policy which endorses reprocessing for breeder RD&D, while avoiding or deferring it for LWR recycle or waste management?

A. Both the INFCE and the NASAP studies found that there are only marginal economic benefits from recycling of plutonium in light water reactors and that reprocessing of spent nuclear fuel is not necessary as a means of waste management. In addition, major moves to recycling of plutonium in thermal reactors could serve to catalyze the early widespread use of plutonium in nuclear power plants throughout the world. The Administration, as a result, favors a U.S. approach that would avoid or discourage reprocessing for these purposes.

A key NASAP finding was that it would be preferable if reprocessing services "were to be supplied based on schedules driven by fast breeder and advanced reactor research and development needs where there exist both economic and technical justifications." Within this context, the Administration continues to support a reprocessing RD&D program as required for the liquid metal fast breeder system.

No. 4

Q. At the time the nonproliferation policy was announced and shortly thereafter, the Administration sought to gain acceptance of its view by offering a number of inducements to those nations adhering to U.S. nonproliferation objectives. All of these inducements seemingly have been delayed. Could you give us a status report on some of these programs, such as U.S. storage of foreign generated spent fuel? The creation of an International Nuclear Fuel Bank? The Portsmouth add-on?

A. The United States continues to offer inducements bilaterally and through prospective multilateral arrangements to countries prepared to accept our nonproliferation goals. Overall, we believe that U. S. nonproliferation interests will best be served to the degree that other nations have confidence that we will remain a stable and attractive nuclear supplier. With respect to the specific programs mentioned in your question, we are doing the following:

-- The Administration continues to support legislation currently before the Congress to create a program for away-from-reactor (AFR) storage of spent power reactor fuel from domestic utilities as well as a limited amount of spent fuel from foreign countries when the U.S. storage would further our nonproliferation objectives. We are also actively participating in a study of international spent fuel management under the auspices of the International Atomic Energy Agency, which is examining how improved international cooperation can help countries meet their spent fuel storage needs.

-- The United States is continuing to explore the concept of an international nuclear fuel bank with other countries. We anticipate that this subject may be discussed in greater detail by an IAEA Committee on Fuel Assurances that was just established by the IAEA Board of Governors.

-- U.S. enrichment capacity is being expanded. A program for increasing the output of the three gaseous diffusion plants by 10.1 million SWUs will be complete by 1983. The first increment of the Portsmouth Gas

Centrifuge Enrichment Plant will be operational in 1989, and present plans call for having the full plant on line in the mid-1990's. Although the original schedule of the Portsmouth Plant has been delayed by one year in support of the President's anti-inflation efforts, the Department of Energy will be able to meet the anticipated requirements of all domestic and foreign enrichment customers.

In addition to the programs mentioned in your question, we are taking other steps to encourage foreign nations to support our nonproliferation policy goals. These include the following:

-- We have streamlined the procedures for reviewing and issuing export licenses for nuclear fuels in order to improve our reliability as a supplier. The NRC has accepted the recommendation of the Executive Branch that single multi-year licenses for exports covering the initial and three reloads of fuel be issued for new reactors and for five reloads for existing reactors when the recipient country has good nonproliferation credentials.

-- The U.S. has just informed the IAEA that it is prepared to undertake under IAEA auspices a special program designed to assist the Agency and countries party to the NPT and the Treaty of Tlatelolco in identifying specific training requirements for manpower development for nuclear power programs. This is over and above the extensive assistance we already are furnishing to the IAEA technical assistance program through cash contributions and grants of "in kind" assistance.

-- The U.S., as already noted, is working toward the conversion of research reactors from presently used high enriched fuels to lower enriched fuels when such changes do not diminish reactor performance and involve no change in safety standards.

-- International cooperative programs to improve the efficiency of the LWR on the once through cycle have been initiated. If successful, such programs will facilitate the commercialization of improved LWR technologies in the international community.

No. 5.

Q. This Administration has made conservation the key to its energy program. Yet it continues to ignore the immense amounts of energy contained in spent fuel. Granted there are risks with reprocessing, but there are also health risks from other forms of conservation such as insulating one's house. Have such risks even been compared? Or are we treating each in isolation?

A. We have taken the position that reprocessing for the purpose of recycling plutonium in thermal reactors is not compelling economic and involves unnecessary proliferation risks at this time. As already noted, the International Nuclear Fuel Cycle Evaluation also agreed with the U.S. view that the economic benefits of thermal recycle are not large. Consequently, we see no major need at this time to move to thermal recycle and we sense that several other nations share this view or are moving in this direction. The Administration policy of deferring reprocessing of light water reactor fuel in no way implies a waste of the contained fuel values as the option to subsequently reprocess is not foreclosed.

No comprehensive cost-risk/benefit comparison of alternative energy technologies has been prepared by DOE. However,we have recently testified in support of the evaluation of risks associated with potential electrical energy sources, as proposed in H.R. 7190.

No. 6

Q. The post-INFCE judgment of the Administration on spent fuel storage was apparently expressed by Ambassador Smith in his statement on the INFCE Final Plenary Conference when he observed "spent fuel can be safely stored on an interim or long-term basis and permanent disposal without reprocessing appears to be a realistic option for either economic or nonproliferation reasons." Isn't it true that thermal reactor spent fuel from the once-through fuel cycle following the loss of its initial radiation barrier is the only fuel cycle with a residual proliferation risk? Is the Administration convinced that spent fuel reprocessing would not contribute to better long-term proliferation resistance for spent thermal reactor fuel?

A. In our view, INFCE recognized that each nuclear fuel cycle entails some proliferation risks even though the incentives to proliferation are predominantly political in nature. NASAP concluded that, in comparative terms, the once-through fuel cycle involves less risks than alternatives.

Spent fuel from thermal reactor fuel cycles will generally have lower radiation exposures and hence will be somewhat easier to reprocess than higher exposure fuels such as would be typical of fast breeder reactor operations. On the other hand, the radiation barrier in spent fuel remains significant for a long time. As spent fuel becomes older, it can be reprocessed with somewhat less technical effort and sophistication because of the gradual decay of radioactive products. However, the decay process is a slow one, and the required reprocessing technology is basically unchanged for 100-150 years after discharge from a reactor.

In comparing the proliferation risk of alternative fuel cycles, we believe that the availability and possible misuse of reprocessing technology and facilities presents a greater risk than the spent fuel itself. Spent fuel does not pose a major threat by itself because plutonium (or fissile uranium) would have to be separated by chemical reprocessing. If reprocessing technology and facilities were more widely disseminated, there would be a greater potential for diverting the use of plants to acquiring plutonium for weapons. Hence, a major goal of discouraging reprocessing is to limit the accessability of separated plutonium. Primarily for this reason the once-through fuel cycle is judged to provide the greatest proliferation resistance.

No. 7

Q. **Isn't it true that INFCE concluded that in terms of environmental impact of nuclear waste management, the once-through thermal reactor fuel cycle is the least favorable and the breeder reactor cycle the most favorable? What is the Administration's view as to the effect this conclusion should have on current U.S. reprocessing and breeder policy?**

A. The assessment of environmental and health impacts within INFCE was performed primarily by Working Groups 5 and 7, with the latter having carried out the most detailed assessment, taking into account all waste, including that associated with uranium mining. Working Group 7 concluded that the contribution of waste disposal to the collective dose commitment is a very small fraction of the annual exposure to natural background radiation and is of the same order as that of the other phases of the fuel cycle. Working Group 7 generally concluded, taking into account not only health and safety and environmental impacts but also the other assessment factors, that, "The difference in the impacts of waste management and disposal among the reference fuel cycles does not constitute a decisive factor in the choice among them. Employing technology as assumed, the radioactive wastes from any of the fuel cycles studied can be managed and disposed of with a high degree of safety and without undue risks to man or the environment." However, Working Groups 5 and 7 also found that the radiological impact of waste management is mainly correlated with uranium demand and is largest for the once-through fuel cycles and smallest for the FBR cycles.

Environmental considerations are an important factor in selecting fuel cycles, but when weighed against other factors there is no basis at this time to prefer one system over another.

No. 8

Q. **INFCE found certain technical steps, such as coprocessing, would tend to increase diversion resistance but that considerable development work would be required before they could be introduced on a commercial scale. In your judgment, how could the U.S. assist in proving the technical and economic feasibility of these more diversion-resistant technologies, particularly through the use of programs or facilities which already exist or could be made available in the near future?**

A. The Consolidated Fuel Reprocessing Program (CFRP) which is funded under Fuel Cycle R&D and is centered at Oak Ridge National Laboratory has been and continues to develop the required technology to determine the technical and economic merit of alternative reprocessing flowsheets. The facility which is scoped to provide the technology demonstration is the Hot Experimental Facility (HEF). The HEF is an engineering-scale facility designed to reprocess breeder fuels as well as LWR fuels for initial breeder cores. The reference flowsheet for the HEF is a coprocessing flowsheet. The completion of the conceptual design for the HEF is scheduled for January 1981.

The U.S. submission to INFCE on "Proliferation Resistance Assessment of Nuclear Systems" dated September 1978, stated that coprocessing "would significantly increase the amount of material that had to be removed from the fuel cycle and would require the proliferator to chemically separate plutonium from uranium. In themselves, these difficulties may not be major." This suggests that from a proliferation resistance standpoint coprocessing is a step in the right direction; however, it is only likely to be a modest one principally of value in dealing with sub-national threats of diversion.

No. 9

Q. In estimating the sufficiency of uranium reserves, one is confronted with estimates of almost 100 percent difference in the number of light water reactors which will be on line in the year 2000. What is the latest DOE projection? How many reactors could be on line if a future Administration would make it possible to construct and operate enough nuclear reactors to meet reasonable projections of electrical energy demand by 2000, along with maximum development of coal and renewable sources? What would be the impact of this on U.S. uranium reserves? On domestic enrichment capacity? On the future need for reprocessing and the breeder?

A. We have previously testified before the House Appropriations Subcommittee that Industry should be capable of having 400 GWe on line by the year 2000. We have no estimate of NRC's capability to license this number of reactors; however, standardization would help in this regard. We believe there are adequate uranium resources and adequate enrichment facilities either existing or planned to support 400 GWe LWRs. As previously indicated in other testimony before this Committee, we believe breeders will be needed and should be deployed about 2020. Reprocessing needs are directly related to the breeder deployment.

No. 10

Q. Given that many nations argue for the breeder because they see scarce world uranium supplies, and also see the U.S. as "guzzling" available supplies through inefficient nuclear fuel cycles, what is DOE doing to support the U.S. argument that there, indeed, is enough uranium and how does this square with the drastic cutback in the NURE program?

A. Although the role of nuclear power in meeting U.S. energy needs will continue to increase in the future, the pace of nuclear growth has slowed in recent years. The reduction in the National Uranium Resource Evaluation (NURE) budget in FY 1981 reflects a somewhat lessened sense of urgency regarding the completion of a comprehensive study of U.S. uranium resources. The NURE program continues to be an ambitious effort to systematically and comprehensively evaluate U.S. resources. While a reduced program activity and modified approach may require a longer completion time, the results will provide a continually improving basis for developing energy policies, programs and priorities.

No. 11

Q. It must be evident to the Administration that there are basically no technical secrets of any significance remaining in such fields as nuclear fuel reprocessing. The fact that so many other nations of the world have developed capablity in reprocessing without benefit of U.S. transfer of technology is a reasonable demonstration of that statement. On what basis can the U.S. pretend to impose a unilateral position regarding reprocessing on such nations as Japan who are dependent upon imported fuel to the extent that they must seek and develop all alternatives?

A. The U.S. believes that the widespread and premature development of reprocessing facilities would significantly reduce the barriers between the peaceful and military applications of nuclear energy. Accordingly, we have taken a number of steps in our dealings with other nations to reduce that risk. Every effort has been made to undertake these steps in a spirit of cooperation and with due sensitivity to foreign energy needs and concerns about spent fuel disposition. While some important differences of opinion still must be resolved, there is a growing appreciation of the risks and benefits associated with the technology.

With respect to Japan, we have sought to fashion our bilateral relations in ways that recognize Japanese energy concerns and in ways that are supportive to nonproliferation objectives. For example, in 1977, we agreed to the reprocessing of a limited quantity of U.S.-supplied fuel at the Tokai Mura facility under carefully monitored conditions. We are now in the process of extending that agreement for a second time until April 1981. This extension is associated with a Japanese commitment to continue to examine the feasibility of co-processing and to work with the U.S. and the IAEA cooperatively on advanced safeguards R&D at the plant. In addition, the Department of Energy has approved, subject to the requirements of the Nuclear Nonproliferation Act of 1978, several Japanese requests to retransfer U.S.-origin fuel to the United Kingdom and France for reprocessing since these requests have met our existing criteria for approval.

Thus, our policy has sought to avoid imposing unilateral positions on other countries regarding reprocessing and has attempted to recognize the energy concerns of our cooperative partners. This has manifested itself in our bilateral relations as well as in our willingness to freely discuss the various options in an objective fashion in INFCE.

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No. 12

Q. A recent NEW YORK TIMES noted that France is proceeding rapidly with the Super-Phenix reactor to replace its reliance on foreign oil. While the Administration has opposed the construction of the Clinch River Breeder Reactor for various reasons, the latest seems to be that given the availability of alternative fuels, the U.S. doesn't need to move quickly in this area. The unfortunate fact is that the development of domestic coal reserves has been a national priority for seven years now, yet coal development has yet to significantly expand. Are such considerations taken into account in your projections on the need for the breeder?

A. Yes. The demand for both nuclear and coal resources has been affected by the decline in projected overall electrical energy demand.

No. 13

Q. The U.S. position with respect to fast breeders appears to be one of recognition of the ultimate need for such energy sources but a serious disagreement as to the timing for the commercial introduction of this technology.

-- What information has been developed by the Administration to support this contention that nothing more need be done at this time other than some cooperative research and development.

A. The Administration continues to support a broad based LMFBR development program aimed at advances in critical technical areas such as sodium heat transport systems, fuels safety and proliferation-resistant breeder reprocessing technology. This technical and engineering information, coupled with uranium supply and electricity demand studies, will provide the basis for a future decision on when to proceed with further plant development and commercialization. Factors considered in arriving at this position, with regard to timing, are described in National Energy Plan II.

-- Have any studies been undertaken which will clearly demonstrate that there is sufficient time between now and the year 2010 to accommodate the complex, technically demanding, institutionally uncertain steps that must be taken before commercial feasibility can be established?

A. In a parallel effort to the Conceptual Design Study of the next development plant, we are preparing a revised analysis of the overall need and timing question.

RESPONSES TO ADDITIONAL QUESTIONS
REQUESTED OF
DR. MARVIN K. MOSS

Question 1: What is the specific logical connection between the U.S. domestic nuclear program (that is the breeder, reprocessing, etc.) and our non-proliferation strategy?

Answer

The Administration's policy from the start has recognized the need for compatibility between our domestic nuclear program and our international non-proliferation strategy. If policies in these two areas work at cross-purposes, our credibility and effectiveness will inevitably suffer. The decision in April 1977 to defer commercial reprocessing and recycle, and to redirect the breeder reactor program away from an emphasis on early commercialization, was based on mutually reinforcing analyses of the economic and security implications of an early transition to sensitive fuel cycles. In brief, it was concluded that earlier assumptions about nuclear power development had overestimated the urgency (in economic and resource terms) and underestimated the risks (in proliferation terms) of rapid and widespread movement toward reprocessing, commerce in plutonium fuels, and other sensitive nuclear activities.

Increased concern about the proliferation risks of widespread access to and premature use of weapons-usable material led the U.S. to urge caution and restraint in moves toward plutonium cycles. At the same time, economic analysis--in light of projected nuclear power demand and uranium resource availability--indicated that such caution and restraint need not carry a penalty.

Accordingly, the adjustments in U.S. domestic breeder and reprocessing programs have had a double logic: they flow from economic analysis that early commercialization of plutonium cycles is premature; and they support our international argument that, in view of their proliferation implications, such cycles should not be introduced prematurely or before further improvements have been made in the nonproliferation regime.

Question 2: Our allies and the developing nations are accusing us of being nuclear wastrels. Just as we have burdened the world oil supplies--we will overtax the world's uranium supplies--unless we move ultimately to breeder reactors. There will, indeed, be little uranium available for the deployment of converter reactor systems in the developing nations. Not only is our current policy one of self-denial but it is also a policy of denial to those nations who seek a higher standard of living. What are your views on this perception?

Answer

The question of "self-denial" is treated in our answer to question three. With regard to overtaxing the world's uranium supplies, several points can be usefully made. The latest available estimate of U.S. installed nuclear capacity (January 1980) is 196 gigawatts by the year 2000. Just the "reserves" plus "probable reserves" category of the DOE estimated U.S. uranium resource base is adequate to support around 500 GWe. Moreover, the reserves plus "potential resources" category for the U.S. is almost twice as large. Extensive uranium reserves are also known in Canada, Australia, Niger, and South Africa. The uranium demand and supply balance is such that the price of U_3O_8 has dropped significantly over the past year.

Globally, INFCE Working Group 1 concluded that " . . . uranium supply should be adequate to meet requirements through 2025, although there is inevitably some uncertainty . . . ." In making this statement, the INFCE "low" nuclear demand projection was used; however, the INFCE low projection, made almost three years ago, is considered by many today as being a reasonable, if not a somewhat high, estimate.

As a result of current stuides, including INFCE and NASAP, the U.S. has initiated a strong program to improve the efficiency of the LWR on the once-through cycle. If successful, these improvements will approach the gains expected from recycle and could be in place by the end of the century. Of course, recycle would still remain an option for further resource savings. These LWR performance improvements are a direct result of more efficient in-situ burning of the plutonium generated in the LWR.

Not withstanding all of the above, it is true that the world's uranium suplies may be taxed unless one ultimately moves to breeder reactors. The question today is one of timing. No nation has faced a denial of nuclear power based solely on a lack of uranium reserves, nor is such a situation foreseen by any supply/demand projections.

Question 3: Has the U.S. policy of "self-denial" regarding reprocessing and the breeder been effective in furthering U.S. non-proliferation objectives?

Answer

As the answer to question #1 suggests, it is not accurate to characterize U.S. breeder and reprocessing policy as a policy of "self denial". The U.S. decision to defer commercialization of reprocessing and the breeder was based on economics, the uranium resource base, the demand for nuclear power, and considerations of nuclear weapons proliferation. Analysis confirmed to both the Ford and Carter Administration:

- that in light of projected nuclear power demand and uranium resource availability, an early transition to plutonium recycling in the U.S. was not necessary on economic or on an energy policy basis; and
- that early reprocessing and widespread commerce in weapons usable materials could lead to added proliferation risks by exarcerbating an already strained and not globally prepared international safeguards regime.

Thus, the deferred commercialization of plutonium cycles in the U.S. has been and remains a matter of rational energy policy and economic self-interest. Department of Energy analyses, performed since 1977 including the NASAP study, have reconfirmed and reinforced this conclusion.

At the same time, deferral within the U.S. serves our strategic interests by lending crucial support to U.S. non-proliferation diplomacy. It is necessary in order to lend credibility to arguments against premature reprocessing (i.e., reprocessing in advance of clear economic or technical bases for it or in the absence of improved international nonproliferation safeguard measures). While it was not to be expected that all countries would follow our lead, it is clear that a U.S. decision to proceed with reprocessing against the logic or our own economic and resource analysis would seriously under cut our nonproliferation efforts.

It is, of course, difficult to assess the precise effect of this example on others. Reprocessing and breeder programs are moving forward among some of our industrial allies according to their own national assessment of energy and economic realities.

In some cases, these realities differ markedly from those facing us. However, recent slippages in the schedules of some breeder programs, and the growing consensus against near-term thermal recycle, suggest that other governments are indeed sensitive to the same economic arguments that have shaped our domestic choices. We also sense that we have induced many other nations to show greater caution in moves towards the acquisition, use and export of sensitive facilities and materials.

Question 4: Civilian nuclear power systems are but one of the many possible routes to weapons proliferation. Would you comment on why we are turning our back on an essentially inexhaustible energy supply in the U.S. when: (a) the connection between our domestic actions and our nonproliferation objectives is so weak, and (b) when, indeed, there are easier and more preferred routes to weapons capability than by diversion of the civilian nuclear cycle?

Answer

(a) As discussed in the answer to question #1, in our view the connection between our domestic actions and our non-proliferation objectives is not weak. The deferral of reprocessing and of early breeder commercialization supports both domestic energy interests and international nonproliferation interests, and the relationship between these two is basic and mutually reinforcing. Moreover, the policy of deferral does not mean that we are "turning our back" on an important energy resource, since there is no resource threat to continued use of nuclear power worldwide, and the option to use plutonium in the future, under suitable constraints, is in no way foreclosed. On the contrary, the deferral of thermal recycle offers the opportunity to maximize the potential economic and energy benefits of any eventual plutonium use rather than commit this resource in an uneconomic, unnecessary and premature way.

(b) There are, of course, a number of potential paths to nuclear proliferation, and it is important that nonproliferation policy address all of them. The Administration's policy reflects a concern that the relative risks of proliferation associated with the nuclear power fuel cycle could increase substantially if direct access to weapons usable material, and facilities to produce these materials, became widespread and uncontrolled.

This concern was prompted particularly by the prospect of an early transition to reprocessing and plutonium recycle in thermal nuclear power reactors, and the spread of sensitive fuel cycle facilities and weapons usable materials to numerous additional countries. (The IAEA, for example, had projected that some 46 countries might have reprocessing facilities by the late 1980's). Following the Indian nuclear test of 1974, as well as recent developments in other countries, we have also been concerned about the proliferation resistance of purportedly peaceful nuclear research programs.

These developments do not necessarily imply that peaceful nuclear programs have become the main proliferation threat, and U.S. policies have not rested on any such judgement. Rather, these policies stemmed from a belief that the strict separation between civilian and military uses was in danger of becoming either blurred, eroded, or both, and that this development required new measures to further strengthen the international nonproliferation regime.

These judgements have held up over the past few years, and they have become more widely accepted internationally. Both INFCE and NASAP studied the question of the proliferation-relevance of the fuel cycle intensively, and concluded that this problem--while certainly not the whole of the proliferation issue--exists and must be taken into account in nuclear energy program planning. For example, the final INFCE report treated the issue as follows:

> The construction and planned misuse of fuel cycle facilities is not the easiest nor the most efficient route to acquire materials for the manufacture of nuclear weapons. However, if facilities handling a significant amount of weapons-usable materials are already established, their misuse might well, in some circumstances, be a feasible path to obtaining materials for nuclear weapons. In addition, the technology and know-how acquired in nuclear power programmes, though not directly related, could be drawn on for a subsequent nuclear weapons programme. To that extent, the possibility of misuse of such materials, technology and facilities entails a proliferation risk, which must be balanced against any economic, environmental, energy strategy and resource utilization advantage they may have.

Similarly, the NASAP report states:

> Both the dynamics of evolving nuclear power systems and changing political realities require that the existing regime which controls civilian nuclear activities be reassessed to find ways to strengthen it against the dangers of nuclear proliferation without jeopardizing the development of nuclear energy.

Developments in Pakistan and several other countries in recent years have confirmed the legitimacy of concerns about the actual or potential misuse of allegedly peaceful fuel cycle or research facilities. A realistic nonproliferation policy today must recognize that attempts to keep open or actively pursue a nuclear weapons option under the guise of peaceful activities are by no means hypothetical.

Question 5: In our view, the policy of denial and of empty preachments has failed. A more positive approach would be for the U.S. to move swiftly to breeder deployment than to offer guarantees in good faith for enrichment uranium supply to non-weapons states. If they agree to appropriate safeguards and to return the spent fuel to the U.S., would you accept this approach? If not, why?

Answer:

The approach outlined in this question seems to consist of three separate elements. The first, rapid deployment of breeders, is addressed in other answers. Briefly, the U.S. uranium resource base and projections of nuclear power demand do not indicate a need for rapid introduction of breeders at this time. To accelerate the deployment of breeders in advance of an economic or energy justification for them would detract from, rather than support, our energy and nonproliferation objectives.

The other two elements suggested, improved fuel assurance and the return of foreign spent fuel, have been recognized by the Administration as potentially important nonproliferation measures that could help slow the spread of sensitive nuclear facilities to new countries. In the area of enriched uranium supply, the U.S. has already taken a number of steps to improve foreign confidence in our reliability. These include the planned additions to U.S. enrichment capacity, introduction of new and more flexible terms to U.S. enrichment customers, and the licensing of multiple reloads in some cases. We are also continuing to explore possible international fuel assurance mechanisms such as those considered by INFCE, and expect that this will be an important topic to be taken up by the IAEA in Vienna.

With respect to spent fuel return, the President has, of course, announced a U.S. willingness to accept limited amounts of foreign spent fuel for storage in cases where this would serve nonproliferation interests. Implementation of this policy requires Congressional authorization as stipulated in the Nuclear Nonproliferation Act of 1978 and other relevant legislation. It is doubtful, however, that a mandatory return of all U.S.-origin spent fuel would be acceptable either to the U.S. or to its customers. Our approach to spent fuel storage has emphasized, as a more promising alternative, the improvement of international and multi-national cooperation in making storage capacity available. The expert study on International Spent Fuel Management under the aegis of the IAEA, and our discussions with Japan on possible Pacific Basin storage concepts, are two examples of this approach.

Question 6: Since President Carter's April 7, 1977, announcement of U.S. "Nuclear Power Policy", including indefinite deferral of commercial reprocessing and thermal recycle and restructuring of the U.S. breeder program, can you identify any specific case in which another nation has voluntarily altered its plans in these areas as a result of our policy?

Answer

As noted in the answer to question #3, it is difficult to measure the direct impact of U.S. policy on the programs and plans of other countries. Moreover, to expect others to alter their policies simply because of the U.S. example is to misconstrue the intent and expectations underlying U.S. policy. Instead, the hope was that other countries would come to take more seriously the economic and nonproliferation arguments for caution in moves toward sensitive cycles, and it seemed clear that this would be less likely to happen if the U.S. acted in contradiction to its own recommendations.

The evidence of recent years is mixed on this question. However, there are numerous signs that the points raised by the U.S. are more widely appreciated. These signs include a generally increased sensitivity to the proliferation implications of fuel cycle choices; a much greater awareness of the need for restraint in the export of sensitive nuclear technologies; a growing consensus against near-term pursuit of the thermal recycle option; and deferrals in the schedules of breeder programs in some countries. These developments have not occured "as a result" of U.S. policy, but rather because other countries, like the U.S., are influenced by economic realities and growing concerns about proliferation risks.

Question 7: Statements by at least eight participants at the final plenary session of INFCE called for the further development and improvement of current safeguard methods and technologies (Australia, Denmark, Canada, Egypt, Japan, Netherlands, Sweden, Euratom).

As the leading non-proliferation proponent, it would seem that our domestic safeguard R&D programs would reflect this importance. How do you explain the GAO finding (March 18, 1980) that "the Administration's policy has hampered research and development of ways to safeguard against the diversion of nuclear material"?

Answer

The U.S. has also called for the further development and improvement of current safeguard methods and technologies. At the final plenary session of INFCE, U.S. Ambassador Gerard Smith said:

> "I would stress the importance the United States attaches to applying effective IAEA safeguards to all civilian nuclear facilities, and to providing the IAEA with the additional funds, trained manpower, and policy support it needs to carry out its expanding safeguards responsibilities. While safeguards alone will not be sufficient to minimize proliferation risks from sensitive fuel cycle activities, we are convinced that comprehensive safeguards coverage will be necessary if nuclear power is to play its proper role in meeting global energy needs."

We do not agree that the Administrations policy has hampered safeguards R&D. On the contrary, we are probably the leading nation in supporting the IAEA in the upgrading and improvement of its safeguard capabilities.

In order to maximize reduction of risks from reprocessing facilities, safeguards should be a design basis for the facility. Accordingly, safeguards programs in the U.S. emphasize systematic development of integrated safeguards from the ground up. Current U.S. safeguards development for reprocessing is linked to FBR development. These programs are proceeding very satisfactorily in design studies being conducted at ORNL.

It should be mentioned that the GAO report did not give satisfactory credit to the work at ORNL and elsewhere which integrates technological advances made in safeguards. Major programs in safeguards R&D are also being carried out at Sandia and Los Alamos.

Question 8: Recently, Administration spokesman (e.g., Kitty Schirmer) have begun calling CRBR both premature and outmoded. This seems to me to be contradictory. Would you please elaborate?

Answer

We obviously cannot speak for Ms. Schirmer. However, the design and construction of the CRBR was frozen early in our nuclear development program due to an emphasis on early breeder deployment. A more cost effective and orderly FBR development might have resulted if the FFTF had been completed and operated first. This would have strengthened the technology base and gained operating experience that might have improved the evolution of FBR development. Instead, parallel design studies were initiated on the LMFBR that may have substantial overlap in their ability to generate useful information for further commercial development of FBRs.

The urgency of FBR deployment in the U.S. has lessened to a considerable extent as a result of the substantial reduction in projected electrical power demand in the U.S., a reduction in the projected deployment of nuclear power, and more optimism on the supply of uranium. The French, in contrast, were forced to accept more economic risk in their FBR development program due to a severe lack of energy resources, whether coal, oil, or uranium. The CRBR represents a development stage similar to that of the French Phenix breeder reactor. The Phenix, which has been operational for some time, is rapidly being succeeded by the larger and more advanced Super Phenix breeder reactor. Given this current progress of our breeder development program, CRBR no longer represents a timely or cost-effective step in the program.

Question 9: Do you see any prospect for reaching new agreements with Euratom, Japan and other important nuclear countries until we are willing to specify the circumstances under which they can expect reprocessing approval?

Answer

The issue of predictability in the exercise of supplier consent rights received a great deal of attention in INFCE, and the U.S. has acknowledged that this is one of the important questions to be addressed in discussions of post-INFCE arrangements, including our negotiations with Japan, EURATOM, and others. As Ambassador Smith stated at the INFCE plenary,

> INFCE recognized in a variety of ways that a country pursuing a nuclear power program needs to be able to plan ahead with confidence regarding, for example, reactor fuel supply and disposition of spent fuel... Pointed observations may be found in the working reports about the need for greater predictability in nonproliferation conditions and the prejudicial results of abrupt or unilateral changes in conditions of supply. On the other hand, the reports recognize that suppliers cannot be expected to freeze their policies or to ignore situations that might seriously aggravate efforts to prevent the spread of nuclear weapons.

This balancing of improved supply assurance (including the exercise of reprocessing approvals) and improved nonproliferation assurances will, of course, be a central factor in our post-INFCE attempts to reach agreement with our cooperating partners. We are confident that such a balance can be achieved, although it is obviously futile to speculate at this point on the precise terms of any eventual agreements.

Question 10: Would the U.S. position in international nuclear matters be stronger or weaker if we were constructing a large-scale breeder prototype?

What about operating an industrial scale reprocessing facility?

Answer

The question asked is speculative and cannot be answered definitively. However, our position in international nuclear matters probably depends at least as much on the technological sophistication of our programs as on the timing of particular demonstration projects.

The U.S. has designed, developed, and constructed the world's most advanced fast, liquid metal reactor test facility, that is, the FFTF. The data that will be forthcoming from this facility in the near future should have a strong, positive impact on any future breeder reactor prototype. The FFTF, and its associated breeder R&D, should add immeasurably to U.S. credibility in the international community. It is of course also possible that structuring our FBR program towards a large-scale prototype would be viewed by the international community as a logical progression in a breeder development program. The crucial question would appear to be that of timing.

U.S. reprocessing plans are geared to support of our FBR R&D requirements. Since the FBR requires plutonium from LWR spent fuel for startup, and large quantities of reprocessed fuel for operation, a new facility capable of handling breeder fuels--the Hot Experimental Facility--is being designed at ORNL to accomodate FBR development needs.

The operation of an industrial-scale reprocessing facility designed for thermal recycle would supply only a small part of U.S. FBR development requirements. Excess plutonium over and above start-up requirements would be produced by such a facility, and this excess could quickly become a substantial burden in storage and safeguards costs. Accumulation of large quantities of plutonium would increase pressure to recycle to offset a part of the cost of operating the facility.

Mrs. **Bouquard**. Thank you very much, Dr. Cunningham, for your well-prepared statements.

Dr. **Cunningham**. Thank you.

Mrs. **Bouquard**. I have a number of questions.

First, of all, we would like to go back to page 4, to point 6 of your statement.

Dr. **Cunningham**. Yes.

Mrs. **Bouquard**. This is on your demand for enrichment capability; also, page 8, to expanding our enrichment capability.

Dr. **Cunningham**. Yes.

Mrs. **Bouquard**. How does the NASAP recommendation fit with the $170 million recommendation? I understand the project is 2 years, possibly 3 years. That's a little bit inconsistent if we are planning to go ahead with our enrichment service, and if we have the slippage in our program. Yet, we are encouraging other countries to look to us for their enrichment facilities.

Dr. **Cunningham**. Yes. As you know, the total demand for nuclear power has, unfortunately, been slipping in our more recent projections, as we look at the actual requirements involved. This is not only in the United States. It has also been decreasing some from the planned national growth in a number of other countries as well.

Now, while enrichment plans for the enrichment facilities are still proceeding, both in this country and foreign countries, the requirements for those facilities and their schedules are slipping. This is not only in the United States but in a number of other countries.

With regard to our own program, as I indicated, I think it is necessary that we continue the expansion of the enrichment facilities. But as you also know, this is a very expensive operation. It is one which must be handled on a businesslike basis and one in which we would hope to recoup our investment in terms of the actual sales of enriched uranium. We think that the slippage of the Portsmouth add-on centrifuge plant, is consistent with the actual projected need for enriched uranium, both in this country and in the foreign countries as well.

Mrs. **Bouquard**. I would be inclined to disagree with the fact that our plants would cost more, and it is more economical to go ahead with the facilities at Portsmouth, the centrifuge facilities. We will get into that later.

Dr. **Cunningham**. Yes.

Mrs. **Bouquard**. Our time is limited. What efforts are really under way to develop the future DOE nuclear R. & D. programs in the light of these two reports, the INFCE and NASAP reports, Dr. Cunningham?

Dr. **Cunningham**. There are a number of areas that we are pursuing very actively. First of all, in the enrichment area, as you know from our testimony in support of the authorization of our programs, we are proposing a very active program in the area of advanced isotope separation. This technology, we believe, in the long run, will have advantages, both in terms of economics and reducing nonproliferation risks. Our supporting program is very active and very aggressive.

Now, in the area of fuel utilization, we are continuing to emphasize those programs. We have cooperative programs proceeding with a number of utilities and reactor vendors in which we actually have fuel under test in a number of reactors. We have exceeded, in some cases, burnups on the order of 60,000 megawatt days per ton, which is a very aggressive goal in terms of uranium burnup.

Now, as to the supporting safety studies and technical justification for actually operating the reactor fuel to that level, this does require a longer range program. It does require extensive studies, both in terms of the technical justification and safety evaluations. However, we are convinced that we do, in fact, have a program which is very promising and one in which we have already begun to work with the utilities and industry.

We also believe that some of the programs which might not normally be considered as related to nonproliferation such as safety and waste management, are very important in terms of supporting the nonproliferation effort, because these are the factors which lead to more reliable economic, safe, usable nuclear power. Therefore, we are emphasizing all of our efforts in the area of light water reactors.

I should also point out that, since we appeared before this committee the last time, we have indications that we will receive supplemental funding for the Three Mile Island efforts, and we are planning, and have initiated a very aggressive program in support of the work that is associated with Three Mile Island follow-up efforts.

There are a number of areas in the light water reactor area which we are also pursuing aggressively. We think this will have a significant impact.

Now, with regard to fuel assurance efforts, again, we are striving very hard to try to increase the confidence of foreign nations in the United States as a reliable fuel supplier. Over the past few years, in many cases, we have not been considered a reliable supplier of fuel. We do have the capabilities. We are trying to turn around the impression which has been left.

Mrs. Bouquard. There is the agreement on technical points. This includes the findings that breeders are the preferred technology over advanced converter reactors.

Dr. Cunningham. We made a number of studies regarding advanced converter reactors. I think there is a general consensus among all nations, even those which have active converter programs, such as the United States and Germany, that, over the long run, the most significant gains can be obtained by moving into the breeder reactor area.

Mrs. Bouquard. Thank you very much.

Dr. Cunningham. Yes.

Mrs. Bouquard. I recognize Mr. White at this time for questions.

Mr. White. Thank you.

Now, I am curious about what countries have been involved in the negotiations to prevent proliferation. Is India involved, Dr. Cunningham?

Dr. Cunningham. India?

Mr. White. Yes.

Dr. Cunningham. India was an active participant in the INFCE program. I was the U.S. co-chairman for a working group that considered both the light water reactors and advanced converter systems.

Mr. White. Yes.

Dr. Cunningham. In that study, India was not only an active participant, but they also made major beneficial contributions to the report which was produced by that committee.

Mr. White. What about China and the U.S.S.R.?

Dr. Cunningham. First of all, the U.S.S.R. was an active participant, although they participated primarily in working group 5, which was associated with the breeder program. They have a very active interest in the breeder program. They were cochairmen of working group No. 5. They participated in other working groups to a lesser extent.

As I indicated earlier, neither the Soviets nor any of the Eastern Bloc countries contributed information as to uranium resources.

With regard to Pakistan, and my colleagues can correct me here, their participation was not active. They did occasionally have an observer present at a number of the meetings.

Mr. White. What about China?

Dr. Cunningham. China?

Mr. White. Yes.

Dr. Cunningham. Now, China itself, Mr. White, did not participate in any of the activities.

As you may know, they have not chosen to activate their membership in the International Atomic Energy Agency.

A number of years ago, when the question arose regarding Chinese participation in the U.N., the same question arose with regard to Chinese participation in the IAEA. They have not actively pursued the objective of becoming a member of the IAEA.

Mr. White. Thank you.

Dr. Cunningham. Yes.

Mr. White. Are any Warsaw Pact countries now capable of producing nuclear weapons or nuclear supplies, that is, other than the U.S.S.R.?

Dr. Cunningham. As far as the INFCE program is concerned, we had a participant that was fairly active from East Germany. There was one of my co-chairmen—he was a representative from Romania.

Mr. White. Thank you.

Dr. Cunningham. Mr. White, I believe that those were the major participants from the Warsaw Pact countries.

Mr. White. Did they have their own capability in their country?

Dr. Cunningham. With regard to nuclear power, the Czechoslovakians are very active. As a matter of fact, they provide much of the heavy equipment, such as pressure vessels, to the Soviet Union.

The East Germans announced a very aggressive nuclear program. The Romanians are extremely interested in nuclear power.

Mr. White. But they don't have the capability now, Dr. Cunningham.

Dr. Cunningham. The Romanians are developing that capability. I would put them more in the category of one of the advanced developing nations in terms of nuclear capability.

The East Germans, I believe, are quite capable, as are the Czechoslovakians.

Mr. White. Are you suggesting, or would this idea be in line with your suggestion in your testimony, that, perhaps, Dr. Cunningham, one way to have nonproliferation would be for countries such as the United States to process the raw materials from some other country if they sent us uranium deposits, or whatever? We should reprocess them at the time for utilization, and send them back rather than their developing their own refinements.

Dr. CUNNINGHAM. We have, as you know, not promoted that policy ourselves. The Soviet Union, as a matter of policy, requires that a country that utilizes their enrichment services or purchases reactors from the Soviet Union, provide the raw uranium. They also require that after utilization in the reactor, it be returned to the Soviet Union. That is basically their method for controlling nonproliferation aspects. We have not gone that far.

In the United States, as you all know, we have retained control over certain parts of the fuel supplies.

Mr. WHITE. Would that policy seem to be a more fail safe method to insure against some nation misusing nuclear weapons or nuclear materials?

Dr. CUNNINGHAM. I guess, Mr. White, in my personal opinion, it would be effective and beneficial. This is because it is an added measure in addition to the normal safeguards which are available as such.

Mr. WHITE. Why have we not seriously considered that policy, Dr. Cunningham?

Dr. CUNNINGHAM. I don't know that I can answer that question specifically. Again, I think that our overall policy has been one of encouraging responsibility among our allies and responsibility among those countries that we normally deal with. I consider it to be more of a type of action that is taken in any free economy rather than a rigidly controlled, centrally controlled economy.

Mr. WHITE. That is in a perfect world.

Dr. CUNNINGHAM. Yes.

Mr. WHITE. The U.S. interpretation that the INFCE accepts the proposition of recycling has been challenged by the delegates of other INFCE participating countries such as the Swiss and delegates from Brazil. It gives the subcommittee and the administration the advantages and also the disadvantages of recycling.

Dr. CUNNINGHAM. First of all, I should say that all countries clearly recognize and, certainly, it is the U.S. position, that reprocessing and recycling are necessary parts of advanced systems, such as the breeder. We believe that, in terms of both the economics and usefulness, it is more proper to consider the reprocessing of fuel for utilization in the breeders as the breeder development occurs and as it is needed.

Mr. WHITE. Yes.

Dr. CUNNINGHAM. With regard to the thermal recycle, I think, in general, that the study that was done by working group four was a very thorough and effective study. We found, without any armtwisting, that some of the countries which are the strongest proponents of thermal recycling, and this includes countries such as West Germany, also concluded that it was not justifiable on economic terms.

Nevertheless, because of energy security reasons, they probably will continue to pursue the idea of thermal recycle, but not on an economic basis.

Mr. WHITE. One last question. Then I realize that we have to vote.

Dr. CUNNINGHAM. Yes.

Mrs. BOUQUARD. Go ahead, Mr. White.

Mr. WHITE. Going back to the other question. In the Warsaw Pact countries, is the Soviet Union the supplier of refined uranium, or do any of those nations in the pact refine their own uranium?

Dr. CUNNINGHAM. They have a requirement to find their own uranium. Some countries, like East Germany, do not have resources of their own. They seek to purchase the uranium elsewhere. Enrichment services would be provided by the Soviet Union.

Mr. WHITE. By the Soviets?

Dr. CUNNINGHAM. Yes.

Mr. WHITE. The refining is done by the Soviet Union, Dr. Cunningham?

Dr. CUNNINGHAM. Yes.

Mr. WHITE. Thank you.

Mr. MCCORMACK. As you may have heard, we have the bells ringing for a vote.

Dr. CUNNINGHAM. Yes.

Mr. MCCORMACK. We are having a quorum call and there will be a vote following this. It should take us about 10 or 15 minutes to do this. Then we will come back and we will reconvene.

We stand in recess until that time.

[A short recess was taken.]

Mr. MCCORMACK. The committee will be back in order at this time.

I aplogize to you for the delay, gentlemen. We have to live with this all of the time, I am afraid.

I welcome you, Dr. Cunningham. I would like to pick up on a question that Mr. White had asked earlier.

Dr. CUNNINGHAM. Yes.

Mr. MCCORMACK. This concerns the practice that the U.S.S.R. has for, essentially, lending fuel elements to nuclear powerplants outside Russia.

Dr. CUNNINGHAM. Yes.

Mr. MCCORMACK. And then simply requiring their return. This is really the most simple of the effective systems for the control of any potential for diversion of any nuclear material from spent fuel. It is, essentially, the system that we had been advocating in this committee for Barnwell as an international fuel cycle center.

I would like to know, if, as a result of INFCE, the administration is seriously considering any sort of a program. First of all, it would be to activate the Barnwell facility as a multinational fuel cycle center. Second, any sort of a system to effectively encourage nations that do not need reprocessing facilities, such as the South American nations, to not get involved in any sort of reprocessing program, and simply offering to reprocess their fuel. Would you care at this time to comment on that question, Dr. Cunningham?

Dr. CUNNINGHAM. I have two comments.

First of all, with regard to Barnwell, we are not giving any active consideration to that proposal at this time. As you know, we have done a number of studies for this committee. This is both with regard to multinational use and also with regard to the types of reprocessing that could take place at Barnwell.

In addition to the policy questions involved, there is also the question of the expenditures involved.

I believe that we have reported to this committee that we would expect a cost of between $600 and $900 million would be required to put the Barnwell facility fully in operation as a reprocessing facility. We have not proposed any funds for that operation.

Now, with regard to the question of stringent controls of the fuel materials, that is, in terms of supplying the fuel and in terms of accepting the spent fuel, to my knowledge, that has not been considered. Quite a few years ago, it was considered by the joint committee, and it was rejected. I don't believe that we have proposed such an approach since that particular time, sir.

Mr. McCormack. Don't you think that this would be considerably more compatible with the individual autonomy and the individual independence and the sovereignty of other nations than attempting to impose conditions upon them?

Dr. Cunningham. I certainly think that we can make a great deal of progress in the area of offering positive benefits with regard to the fuel assurance, Mr. Chairman, rather than placing so much emphasis on the negative aspects.

As a matter of fact, in some areas, we appear to be imposing negative aspects when, in fact, we actually are not. But that negative aspect has been associated with part of our program. This is one of the reasons that we have difficulty in assuring other nations that we are a reliable fuel supplier at this time and, in fact, we have not defaulted on any fuel supply agreements, but we still have the reputation of the possibility that we will default.

Mr. McCormack. That's an earned reputation, I would suggest.

Dr. Cunningham. Yes.

Mr. McCormack. Certainly there is no aspect to the American foreign policy. It has outraged our potential friends throughout the world as has the arrogance of our nuclear non-proliferation policies. I would presume the administration would be looking to take action, especially in light of the results of INFCE to mitigate that.

You say that there is no contemplation of this at the present time?

Dr. Cunningham. I did not say that. I think that the administration is very actively considering the results of INFCE, Mr. Chairman. We would hope to end up with some positive changes particularly in the area of fuel assurance.

On the other hand, I would say that there was no active consideration, to my knowledge, of actually using the Barnwell plant in that respect.

Mr. McCormack. Do you think that this country can be credible in the world and ignore the presence of the Barnwell plant to reprocess fuel?

Dr. Cunningham. As I have indicated before, a number of times, in testimony to this committee, we really believe that it makes sense to consider reprocessing in terms of a timely approach to the breeder program. That is, it is far more valuable to obtain the residual fuel values in that fuel for the breeder program than it is to consider for possible use in thermal reactors.

Now, in terms of our own policy, I think that it makes sense to encourage people to consider reprocessing only in terms of the breeder reactor. I think that makes more economic sense. I think it is more suitable in terms of the actual energy conservation as well.

Mr. McCormack. Now, Dr. Cunningham, this morning here Dr. Starr took quite the opposite position on that point while speaking before us. It is true, is it not, that INFCE concluded in terms of the environmental impact of nuclear waste management, the once-through thermal reactor fuel cycle is the least favorable and the breeder reactor cycle the most favorable?

Now, Dr. Starr, this morning, pointed out that the spent fuel constitutes a plutonium mine that is very easily minable after about 5 years of cooling. Somehow there is a gross inconsistency here between what the administration says it is trying to do and what it is actually doing.

Dr. Cunningham. The question of spent fuel being a plutonium mine or possibly providing a source of plutonium, was perhaps one of the most extensively debated issues within the INFCE studies themselves. There was a great deal of concern. A number of people did propose the idea that it represents a plutonium mine. But, in fact, when we were through studying all of the systems in their entirety and all of the sensitive facilities within particular fuel cycles, I think there was general agreement, within INFCE, that it would be very difficult to associate one fuel cycle with being more proliferation resistant than another.

In the United States, the NASAP studies concluded the once-through cycle is more proliferation resistant because you do have the potential of providing safeguards. In the case of spent fuel referred to there, one can actually count the number of fuel elements and keep count on them. It's an easier material to safeguard.

Mr. McCormack. We are talking about the entire world, the leadership for the world.

Dr. Cunningham. Yes.

Mr. McCormack. We don't want to have a reprocessing plant in some other country because there might be a takeover by a terrorist group or a coup.

On the other hand, we are willing to put fuel elements in that country that will cool, cool and cool in makeshift facilities.

Dr. Cunningham. Mr. Chairman, I think that we would prefer, if a country were a sensitive nature, that the fuel not be stored there either.

Mr. McCormack. But you know that we don't have that control.

Dr. Cunningham. If it is stored there under international safeguards, it is far easier to safeguard a spent fuel pool than it is to safeguard a reprocessing facility.

Mr. McCormack. But you're taking the worst of two bad options in those situations, Dr. Cunningham, when you have a good one. The good one is to entice them to ship the fuel elements out in the first place for reprocessing.

Dr. Cunningham. As I indicated earlier, that is certainly the Soviet approach. They are very strong proponents of that approach. It appears to be working.

Mr. McCormack. It is a very pragmatic approach. Nobody is developing nuclear weapons around them in their interest. Instead of going through all of these political gyrations that we go through here to try to justify a position, it would be more pragmatic to do this.

I would like at this time to ask Dr. Moss a couple of questions.

Dr. Moss. Yes.

Mr. McCormack. I understand that you were one of the principal policy formulators for DOE for nonproliferation. I should like to ask a couple of questions.

First of all, what, today, is the specific logical connection, if any, between our reprocessing program, the breeder reprocessing, and our nonproliferation strategy? Is there a relationship between building Clinch River as a unique facility and nonproliferation?

Dr. Moss. I'll do my best to answer that question, Mr. Chairman.

Mr. McCormack. Thank you.

Dr. Moss. Clinch River is really under Assistant Secretary Cunningham's directorship. However, as you are very much aware, in the President's policy of April 1977, Clinch River was talked about in terms of nonproliferation. Today, I think we talked about Clinch River not only in terms of nonproliferation, but economics and technical viability and the state of the art.

I think, from a proliferation point of view, the CRBR per se, is not a proliferation threat. The United States is a nuclear weapons state. We are not worried about proliferation in the United States.

I do believe there is an argument that, if we proceed at this point, we will set a precedent for other countries of the world. INFCE concluded that breeders were certainly viable advanced reactor systems for developed nations that didn't have large energy resource bases, that had large electrical power grids that had a heavy component of nuclear power production. In fact, this was one of the arguments that the United States took into INFCE. Indeed, the 66 or so countries participating in INFCE, plus other international organizations, all agreed with us. They talked about breeder reactors not being viable for developing nations, Mr. Chairman.

Mr. McCormack. May I stop you?

Dr. Moss. Yes, sir.

Mr. McCormack. I certainly agree. I think that all of us would agree that the breeder plants have the envision of today and technology that would apply or that would be applicable in the more advanced nations.

Now, the time may come when we find that the breeders are actually sufficiently superior as to cost and they might then actually be a bargain compared to conventional plants. We don't argue this point. I think that everyone agrees that was the unanimous decision.

But that is not really the question so much. In setting a precedent here, we have Britain, France, Germany, Russia, the Western European nations, and Japan all moving ahead of us with their breeder programs. We certainly would not be setting a precedent if we try to catch up with them.

Dr. Moss. That is true. The nations that you mentioned, with the exception of the Soviet Union, are very poor in resources, such as coal, uranium or oil, with the possible exception of North Sea oil for the United Kingdom.

Mr. McCormack. How would we be setting a precedent? We don't expect any other countries to start doing breeder research, do we, aside from those? Would we really be setting a bad precedent? Would it be bad at all?

Dr. Moss. My personal view is that if we enter into a breeder development program that is leading to commercialization in the near term that we, indeed, would be setting a precedent in moving toward a plutonium fuel cycle in the near term future.

Mr. McCormack. You've already modified the question that I asked. Now you are answering a different question.

Dr. Moss. We would be setting a precedent for the United States and Japan.

Mr. McCormack. What I'm talking about here, and I can't quote you exactly, is the suggestion that we committed ourselves to early breeder commercialization. I've not suggested this. I've suggested constantly, in the last 5 years, that we need to be in a position to make a decision on commercialization by the early 1990's, Dr. Moss.

Dr. Moss. Yes.

Mr. McCormack. I think it has been irresponsible for the administration to constantly refer to Clinch River as a commitment to commercialization. We are not talking about commitments to commercialization. I don't think that we should be arguing on that point. Nobody is advocating that point at this time.

Dr. Moss. I agree with that. In specific answer to your question regarding the United Kingdom, France, Germany, and Japan then, certainly, we would not be setting a precedent. However, there is precedent in a country with large uranium resources that could carry, for example, any form of light water fuel cycle that we want well into the next century. There is that precedent. However, I believe that the argument today, even if the initial argument was based to some extent, or to a considerable extent, on nonproliferation grounds, is based more on technical and economic bases. For example, the plant has escalated rather tremendously in cost. The CRBR is about the same size as the Phenix breeder in France, although the technology is slightly different. The French are now considerably beyond the CRBR technology.

I think the argument on the CRBR today is more of a technical and economic argument, although I do feel that for a country with large uranium resources, moving early in this field does bear weighing from the proliferation perspective.

Mr. McCormack. It is my opinion and the opinion of many persons I have talked with across the world, in this country and other countries, that our administration's posture is, which has only been recently changed, that we wouldn't build any breeder under any circumstances even if the President decided himself. That has been his statement to the members of this committee. But don't you believe that weakens our credibility in the world? That makes us less credible in terms of our approach to the nuclear programs in general in being a reliable partner in the field of nuclear energy?

Dr. Moss. You mean for the indefinite future, or do you mean for a specified time period? I am not sure how to answer your question.

Mr. McCormack. I can answer the question two ways. This speaks specifically to this. The President said, "No, I will not build a breeder." When we suggested he design his own breeder to replace Clinch River, he said, "No, I will not do that. That would mean I would build a breeder. I won't build a breeder. If I were the President of France, I'd build a breeder. I'm the President of the United States. I will not build a breeder."

John Deutch said that we may need a breeder in the year 2020. Therefore, we should start the research and development programs by 1985.

Dr. Moss. May I comment?

Mr. McCormack. Yes.

Dr. Moss. I would hope that John Deutch said that the latest Department of Energy analysis, that is, the latest at that time, indicated a need for commercialization of the breeder around 2020, which I think means building a breeder considerably before that time. The commercialization date was the year 2020.

Mr. McCormack. You are completely correct.

How do you think that affects our credibility to try to project our electric energy requirements 41 years in the future, which is what he did last year?

Dr. Moss. The DOE analysis, with which I am quite familiar, having worked with John Deutch for quite a while, yields a spectrum on commercial timings based on the uranium resource base, nuclear demand and economics. For example, many different resource bases were used. Also, it depends on what type of reactors one uses. The demand for nuclear power is, of course, a very important consideration.

The considered opinion of the Department was that 2020 was a realistic date. We would have no trouble carrying light water reactors on a once-through fuel cycle through that period of time. Moreover, DOE thought that was a conservative estimate.

I feel that as far as the nuclear option is concerned, an option which I am very much in favor of, this conclusion was credible.

Mr. McCormack. That was, in fact, projecting needs for 41 years in the future.

Dr. Moss. Yes.

Mr. McCormack. Would you like to go back 41 years in the past and project our energy needs for this year?

Dr. Moss. No, sir.

Mr. McCormack. Yet we based our policy on the assumption that we could do that accurately. Not only that, we took the most optimistic projection of what the future would be in terms of the need for a breeder. We said that we had all the uranium, more than anybody in the world, that we'd have the great reduction in demand which was far below what anybody else said we would need. For these reasons we do not need a breeder for 41 years. I think that reduces our credibility. I think the result of this is that we should correct these things. I know that I am not asking a question. Let me ask you one more question, Dr. Moss.

Dr. Moss. Yes, sir.

Mr. McCormack. Do you believe that this policy of self-denial, and somebody else referred to the self-denial on the breeder and reprocessing, has really improved the nonproliferation atmosphere in the world; that our own denial of these things has accomplished that?

Dr. Moss. That is a difficult question to answer. One cannot perform an analytic determination of the question. I do feel that the atmosphere in the early to midseventies was one that was characterized by high nuclear demands and low uranium resource bases. We have noticed a change today, a rather dramatic change. For example, the

IAEA was predicting that by the late eighties there would be as many as 46 countries with reprocessing plants. Quite frankly, Mr. Chairman, the Ford administration and the early Carter administration saw, through various channels, that there was anticipated misuse of some sensitive fuel cycle facilities on the horizon. We felt that something had to be done.

Now, in the intervening time, INFCE was proposed in order to globally look at these issues. Today, for example, I feel there are really only about three viable reprocessing programs going on. I feel that without the United States having some type of denial program that we would have had no credibility at all in the international community.

I would like, Mr. Chairman, to make one other comment on this if I could.

Mr. McCormack. Yes.

Dr. Moss. Thank you, Mr. Chairman.

Mr. McCormack. Please continue.

Dr. Moss. Referring to the early Ford and Carter administrations, proliferation risks of fuel cycles that involved direct use of weapons material were analyzed. The economic and resource bases of the United States were considered. The decision, first made by the Ford administration, was to defer reprocessing or, at least, weigh it heavily against nonproliferation concerns.

I saw this as not really a policy of self-denial but, at the time, rather one of rational and strategic self-interest.

I think, as INFCE has stated, and I could give quotes to this effect, that fuel cycles that involve weapons usable materials do have implications, serious implications, for future nuclear proliferation. I don't think that those judgments were wrong at the time. I think that we can always go back and reassess these things. However, I don't really feel that the policy was one of self-denial; rather, it was one of concern for economics, resource bases, and nonproliferation, or strategic concerns for the United States and other parts of the world. I feel it was one of strategic self-interest rather than one of self-denial.

That's my personal view, Mr. Chairman.

Mr. McCormack. Thank you.

Dr. Moss. Yes, sir.

Mr. McCormack. I must say that we have spent a good deal of time discussing this. There are several points that I would like to make in response to what you have said. One should not include the Ford administration in making statements about policy. It was said yesterday that we should look at the situation, and that was 3 days before the election, or something like that. It did not, under any circumstances say that we should terminate our breeder program.

I don't disagree with you at all. I think that any wise person would have been concerned about the potential for proliferation if every country in the world started reprocessing programs.

I should like to suggest that, trying to tell them that they can't do it, essentially what our policy has been, which is, I forbid you to do it, this has been a failure. It has caused a great deal more harm. In fact, it has stimulated the potential for proliferation rather than having reduced it. I think that we would be far better off if we had constructive leadership, such as offering the fuel cycle to any country to stimulate development of multinational fuel cycle centers. This is rather than pretending nobody should be recycling, or rather than saying that we shouldn't be doing research on the breeder. I think that we should be saying that there are areas that we should be investigating, areas where we should be taking the lead in establishing international fuel cycle and encouraging others to do the same. Thus, this reduces the potential for reprocessing. This is as well as the storage of spent fuel under conditions where it may be utilized later on.

We could argue this forever, and I won't push you on it. The point that I made to Dr. Moss is the point that I wanted to make to you, Dr. Cunningham. I certainly hope that you would carry back the message to the White House that the committee is looking to the administration to reevaluate our previous position in view of the results of this. I think there can be doubt that the credibility of this country has been dramatically undermined. It was undermined overseas. The credibility of the government is undermined domestically by these policies. They may be perfectly well intended but have been shown to be ill advised.

I hope as a result of these hearings and discussions there will be further explorations and considerations.

As you know, Dr. Cunningham, the committee has directed the Department of Energy to enter into negotiations for the purchase of the Barnwell facility. This is for a multinational fuel cycle. I hope that you will take it seriously at this time.

Dr. Cunningham. We do, Mr. Chairman. We also solicit the committee's help in obtaining from the rest of the Congress the support for our ability to be able to accept the foreign fuel for storage there as well.

Mr. McCormack. Perhaps you are not aware of the fact that the nuclear waste bill that we passed yesterday contains not only the direction to establish four geologic sites for geologic storage for glassified waste, but also the research programs for glassification of low-level waste at the nuclear power plants, not only for the plant itself, but for the surrounding countryside and storage of the waste in weapons caverns, test caverns.

Finally, it was the storage of older spent fuel in the air, in the existing canyons, such as decommissioned separation plants and so on that already are in existence.

Now, this program, if followed through, it strikes me they would have plenty of storage space by storing the old fuel in such places as decommissioned reprocessing plants at Hanford and Savannah River and plants elsewhere.

Dr. Cunningham. Mr. Chairman, I am not aware of the last provision. I am happy to hear about it.

Mr. McCormack. Thank you.

We will cooperate on that.

Dr. Cunningham. Yes; thank you.

Mr. McCormack. I want to thank you very much. We will be looking forward to working with you. Thank you.

Dr. Cunningham. Thank you, Mr. Chairman.

Mr. McCormack. Thank you also, Dr. Moss, for appearing here today.

Dr. Moss. Thank you, sir.

Mr. McCormack. Our next witness is Mr. Myron Kratzer, principal staff consultant, International Energy Associates, Ltd. Mr. Kratzer has been actively involved in international nuclear energy matters and is intimately familiar with many of the views of foreign nations on current U.S. policy and INFCE.

We are looking forward to your testimony on this subject, Mr. Kratzer. You may begin.

Mr. Kratzer. Thank you.

Mr. McCormack. I hope that you can enlighten us on a perspective that we have not encountered.

We have your complete statement at this time.

Mr. Kratzer. Yes.

Mr. McCormack. We will, without objection, put your complete statement in the record.

Mr. Kratzer. Thank you.

Mr. McCormack. You may summarize your statement and proceed as you like.

STATEMENT OF MYRON B. KRATZER

Mr. Kratzer. Thank you very much, Mr. Chairman.

I am very pleased and honored to appear before you today to comment on some aspects of our post INFCE nuclear energy policy.

I will accept your invitation at this time to try to now summarize my testimony.

Mr. McCormack. Yes.

Mr. Kratzer. My prepared testimony is a bit too long.

You have heard a great deal about INFCE. I don't want to repeat here what others have said, but because it is more or less the starting point for some of the comments that I would like to make, I would like to give you my own brief impressions of it.

I think INFCE is a beneficial development in nuclear policy, coming at the time that it did. The fact is that there was a super-heated atmosphere in 1977, and the very fact that INFCE was organized and provided a 2-year breathing spell was perhaps its single most important accomplishment.

There were a few specifics that I think were worth noting. I think there was some modest, but nevertheless real convergence in the views by the various principal nuclear nations. What I mean by the real convergence is not just that we changed our views. I think that we really did, but I think others have, too. I think there was a heightened appreciation for the fact that there are real proliferation risks in the nuclear fuel cycle on the part of other countries which were somewhat reluctant to accept that proposition earlier. I think, on our part, we clearly moderated our views about the unacceptability and risks of certain so-called sensitive parts of the fuel cycle.

Administration witnesses may be more reluctant to say what I have just said, but, as an outside observer, I believe that happened.

I think it has been widely said that INFCE has laid to rest the proposition there could be a technical fix to proliferation risks of the fuel cycle. There are none. They were not found.

There was a consensus that there aren't going to be any technical fixes. At the same time, it was accepted, I think, that there are certain parts of the fuel cycle that exhibit more than ordinary proliferation risks.

Now, basically, Mr. Chairman, these are the ones that produce plutonium, the so-called sensitive parts of the back end of the fuel cycle.

As you correctly pointed out this morning, the front end has proliferation risks as well: The parts of the fuel cycle that have a potential of producing enriched uranium, especially highly enriched uranium.

There is another aspect to INFCE. That is the recognition that the breeder reactor is really the keystone of the long-term use of the nuclear option. Without the breeder, nuclear energy can be important, but it can never be really a long-term energy option for the world. Plutonium is the key that unlocks the energy values of our limited uranium reserves.

At the same time, there was a consensus referred to quite frequently here today, and I assume yesterday as well, that the use of plutonium in light water reactors has relatively marginal economic benefits.

Finally, there is the proposition that institutional means for reducing the proliferation risks are more promising than technical ones. I think it is a very important fact that the United States did join in the action taken by INFCE, including a referral of the report to the governments. It didn't contest the report. It isn't bound by the results. But that is, in my view, a major step forward which gives us a new basis for the formulation of the post-INFCE policy.

You asked several questions. I will try to be responsive to those in summarizing my testimony.

One of those, and it is a very key question, is what is the linkage between the civilian nuclear power activities and nuclear weapons? There are people that argue every side of this issue. There are those that say there is little or none, to those that say it is the most serious proliferation risk in the world today. I think, clearly, those extremes are just that. They are the extremes. They are not the middle ground. I think it is absolutely essential if there is to be consensus on nuclear energy policy, that there be some agreement about the linkage between the civilian nuclear power fuel cycle and nuclear weapons. Basically, that linkage is that it is one of many, but not by any means, the only one, and under many circumstances, not the easiest route to nuclear weapons material. It is one that has not been used yet. However, we cannot rule out the possibility it will be used in the future simply by stating correctly that it hasn't been used in the past. So, we need to have that as a rather universal acknowledgement if we are going to get anywhere in the evolution of the post INFCE nuclear policy.

Now, I believe that some of the basic points on which INFCE seems to reach a degree of consensus provide the basis for a realistic compromise for a post INFCE policy in this very difficult area of the back end of the fuel cycle. This is really what most of the issue is about.

I think that the word "compromise" is important here, Mr. Chairman. I simply do not think it is realistic to believe that after this very contentious period and this traumatic debate for 2, 3, or 4 years, that we can go back exactly where we started. We are not going back, in my judgment, at least, to the pre-1977 policy or the pre-1976 policy. If there is going to be a consensus, I believe there must be restraints on the sensitive fuel cycle activities that were not considered to be that important in the past. I think a basic element is that there must be a compromise, a middle ground, Mr. Chairman, between positions that some have taken in the past and the very rigid position that appears to be the consequence of the April, 1977 policy statement. It seems to me that the elements of that policy might be along the following lines:

First of all, we should acknowledge that there are risks in the use of plutonium and in the operations which give rise to plutonium and reprocessing of a rather serious nature. At the same time, we must accept the proposition that the energy values of plutonium simply are not going to be discarded. They are far too important for the world's energy future, and that of our own, for that to take place. On that score, I would like to make a rather favorite point of mine. I believe that the energy importance of the breeder and, therefore, plutonium, is consistently understated. We all read or hear that the breeder increases the amount of energy that we can derive from our uranium resources by something like a factor of 50. But, really, that is a serious understatement. The fact is that, as we go to the breeder, the plutonium-based breeder, we can open up for energy use uranium reserves of almost any grade, regardless of how high cost they may be, such as the uranium of sea water.

Through the use of the breeder, nuclear energy becomes an inexhaustible energy supply. That's a target which the world is simply not going to move away from.

Now, the other part of the compromise is possible because the light water reactor plutonium recycle is a relatively marginal activity. It should not be engaged in at least so long as we have not put into place more effective institutional arrangements for proliferation risk control. I believe that forgoing plutonium recycle is a controversial point with our own industry and with many countries, but I think that the fact that INFCE was able to agree on the relatively marginal economic benefits of the LWR recycle suggests it is a feasible part of the compromise solution.

Nevertheless, there must be, there has to be, reprocessing, Mr. Chairman, for, I think, rather simple reasons, although they are not always clearly stated.

First of all, reprocessing is an integral part of the breeder reactor technology. You don't have a breeder reactor option, until you have a reprocessing technology in being on an industrial scale that is capable of being put into use on a schedule which is consistent with the ultimate deployment of breeders. You don't get that reprocessing technology without going through the very same process that you have to follow on the reactor side of the technology itself: In other words, by full-scale demonstration.

Second, you need reprocessing on a substantial scale—I prefer to call it the industrial scale rather than a commercial scale because that avoids the issue of who is running the facility—you need reprocessing on an industrial scale to get the substantial quantities of plutonium that will be needed for the breeder development demonstration, and for early deployment. For these two reasons, you have to have large-scale reprocessing facilities running in certain places in the world where breeder reactor demonstration programs are in being and where they make sense. This is part of the overall regime.

Now, at the same time, that doesn't mean that all of the plutonium or spent fuel being discharged from all of the reactors in the world has to be reprocessed on a current basis. As a simple fact, it is not being reprocessed on a current basis. We need what I call extended spent-fuel storage. I think it is important to gain acceptance of the proposition that this is a sensible way of managing spent fuel for quite a period of time. Reprocessing that is devoted exclusively to spent fuel or waste management or reprocessing devoted exclusively to the separation of plutonium for light water recycle is reprocessing that I think we can do without for the time being. Some may say that this is an illogical outcome. If we are going to have reprocessing in the world, why does it matter whether it is for one purpose or another. But there is a logic to it. The logic is that the adoption of light water plutonium recycle as more or less the norm of the current generation fuel cycle would have a far greater effect in dispersing facilities for reprocessing and dispersing plutonium than would the kind of program that I have outlined. Light water reactors are operating in some 20 countries. It would be very difficult to draw a line and say here are the countries that are entitled to reprocessing for light water reactor recycle or entitled to maintain plutonium inventories for that purpose. I believe there is a logic in the sort of compromise proposal I have outlined.

Mr. McCormack. May I interrupt you?

Mr. Kratzer. Yes.

Mr. McCormack. You say that you could do without reprocessing for the fuels for LWR. I am trying to paraphrase. When you say "we," do you mean the United States or the free world?

Mr. Kratzer. I am talking about the free world consensus that, hopefully, could be reached. It might be a tacit consensus without any written instruments acknowledging that this is the policy, but something that comes about by practice.

Mr. McCormack. This is obviously based on the assumption that we can produce enough new uranium to provide the fuel for our projected demands for light water reactors. What about Germany or Japan. They have no guaranteed supply of uranium, Mr. Kratzer.

Mr. Kratzer. I am talking, Mr. Chairman, about a regime that would not last forever. I believe that the separation of plutonium from spent fuel and its use in breeder reactors initially for research, development and demonstration, and, as time goes on, for deployment, is a more energy effective use of that resource.

There may be a gap between breeder introduction and the availability, particularly to these countries you mentioned of low cost, economic uranium. However, I don't believe that gap will arise. There is, of course, a gain in the efficiency of energy utilization, of uranium resources through plutonium recycle in light water reactors, but to say that really materially changes the energy independence situation of countries such as Japan and Germany is rather difficult to sustain. It is quite true, and I think that this is what you are implying, that countries like Germany and Japan really don't look at how much uranium there is in the world. They look at how much uranium they can get. That is what determines their nuclear energy policies. But simply because the light water reactor recycle extends uranium resources by something like 30 percent doesn't give a country with essentially no domestic uranium energy independence.

I find it a little difficult to postulate a situation where a country can acquire 70 percent of its uranium needs but can't quite get the remaining 30 percent. Thus, I don't think there is a convincing energy independence argument for light water recycle.

I don't say that what I have put forward is an ideal situation. What I really am saying is that, unless there is some give or compromise, it's going to be very difficult to regain the consensus that we once had. I believe that this is the logical area for compromise. I think to make war on the breeder, as some people put it, is totally out of the question. That's not a viable policy. To go back to where we started is not a viable policy. I tried to find an area of compromise, and this seems to be it.

[The prepared statement and additional Q's and A's asked of Mr. Kratzer follows:]

TESTIMONY PREPARED FOR PRESENTATION TO THE SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

June 5, 1980

by Myron B. Kratzer

Principal Consultant

International Energy Associates Limited

Mr. Chairman and Members of the Committee:

It is a privilege to appear before your Committee to present views on several aspects of post INFCE nuclear energy policy. Since the firm with which I am associated examines nuclear issues for a number of governmental and private clients, I want to stress that the views which I express here today are exclusively personal ones.

The conclusion of INFCE marks the beginning of a new phase in the nonproliferation policy review which began with the Indian nuclear explosion of 1974. It is a phase that entails both opportunity and risks: opportunity, because INFCE did succeed, even if only modestly, in narrowing the differences in nonproliferation outlook and policy among the principal nuclear nations; risks, because with INFCE ended difficult issues postponed during its conduct must now be faced squarely. As time goes on, the risk that these postponed issues will become intractable will grow, while the opportunity for the United States to influence the outcome in constructive ways will decline. The window for effective United States action is a small one. Thus, you and your Committee are to be congratulated for the initiative you have taken in exploring these issues promptly.

Few principles have achieved such a broad measure of support, both domestically and internationally, as has nonproliferation - the desirability of avoiding the spread of nuclear explosives to additional nations. Yet few principles on which there is such broad agreement have generated such deep and contentious divisions on how they might be fulfilled as has nuclear energy. These differences, I believe, arise from three fundamental sources:

- First, genuine disagreement over the extent of the risk that nuclear power might stimulate or facilitate proliferation.

- Second, the unfortunate attitude, shared in some measure both by many supporters and many opponents of present nonproliferation policies that the goals of widespread application of nuclear power and nonproliferation are somehow in conflict.

- Third, disagreement over the effectiveness of the current nonproliferation regime in reducing the risks of proliferation from the use of nuclear energy.

These three fundamental differences give rise, of course, to many more detailed conflicts. To obtain a better picture of the nonproliferation debate and the impact of INFCE on the prospects for its resolution, it is of interest to look at each of them in turn.

First, the disagreement as to the proliferation risks of nuclear energy. This is an issue on which differences exist both within the United States, and among nations. At the extremes, there are some who contend that the use of nuclear power is essentially irrelevant to the risk of proliferation, just as there are others who contend that even the safeguarded use of nuclear power represents the gravest proliferation threat in the world today. Each of these one-sided views is as indefensible as the other. The fact that the six countries which have demonstrated nuclear explosives to date have not relied upon the nuclear power fuel cycle to do so does not prove that this can never happen. The chances that it might are greater today than at any time in the past if for no reason other than the great increase in the number of countries employing nuclear power and conducting some fuel cycle operations.

But the proliferation risks of nuclear power clearly cannot change the fact that there are other routes to the achievement of a nuclear explosive capability - routes which in many circumstances, will be quicker, easier, and less subject to outside interference or objection. The abandonment of nuclear power will not eliminate the risk of proliferation any more than the application of nuclear power has made proliferators out of all who have sought its benefits.

Acceptance of the principle that the application of nuclear power constitutes one, but only one, of several possible routes to proliferation and the corollary principle that some phases of the nuclear fuel cycle represent greater proliferation risks than others is an essential first step to a new international nonproliferation consensus. INFCE was successful in fostering the acceptance of this principle, although it did not entirely eliminate national differences in the perception of the proliferation risks of nuclear power. Today, most other nations continue to hold the view that proliferation is less linked to the availability of material from the nuclear fuel cycle than in the prevailing view in the United States.

The differences in proliferation risks among various fuel cycles is an important sub-issue to the general question of the linkage between nuclear power and proliferation. Any activity which represents some progress along the complex path by which uranium in the ground is converted to a nuclear explosive material can somewhat increase the chance that the nation which engages in that activity will take advantage of it to develop nuclear explosives. In that sense, there are no proliferation-proof fuel cycles, and it is for that reason that the elaborate system of international assurances and safeguards which we call the nonproliferation regime has come into being, even to afford protection against the abuse of nothing more than the operation of power or research reactors.

The question of which of the steps of the fuel cycle will be easiest for a nation to undertake on its own does not have a self-evident answer. Some nations which could design and build reactors through their own efforts only with great difficulty might find it relatively easy to construct workable reprocessing plants. For other countries, the reverse might be true. What is unarguable as a matter of logic, however, is that the possession of all the fuel cycle steps leaves a country in a better position to misuse the fuel cycle than if it possessed only a part of the fuel cycle. INFCE dealt with this complex situation, concluding that "...no single judgment about the risk of diversion from the different fuel cycles can be made that is valid both now and for the future."

Implicit in this overall judgment is the fact that technical barriers are inevitably lowered with the passage of time, partly because specific technology tends to be dispersed, but even more importantly because the technological capability of countries increases. Some countries which today could build a reprocessing facility, for example, only with great difficulty if at all will find this a much easier task in the future. This fact tells us a great deal about the improvements which we should be seeking in the nonproliferation regime and where our efforts should be concentrated.

The second area of disagreement which I identified earlier as a fundamental source of differences in nonproliferation policy is the supposed conflict between good nonproliferation policy and good energy policy. Unfortunately, INFCE itself tends to foster the belief that there is a fundamental tension between these two goals, and that trade-offs between them may be necessary.

The dichotomy is a false one or, at the very least, a drastically overstated one. The nonproliferation regime of today was achieved not by withholding the benefits of nuclear energy, but by offering them. The assurances and safeguards which we now have against the misuse of civil nuclear activities would have been unattainable had not the U.S. and other advanced countries been willing to share these benefits. I know of no basis on which to conclude that the same principle is not applicable to the attainment of the improvements in the nonproliferation regime which are clearly desirable. Thus, good nonproliferation policy is, virtually by definition, good energy policy as well.

The dichotomy is a false one for another reason. As countries become more heavily committed to nuclear power for a significant part of their energy needs, their own stake in avoiding the interruption which would result from any misuse in correspondingly increased. Conversely, if nations, or the world as a whole, were persuaded to abandon or greatly restrict their nuclear programs, many of the restraints by which they are bound to use these efforts only for peaceful purposes would be loosened, and the activities already in place would present themselves as more attractive sources of nuclear explosive material.

In every country, there are individuals and groups who oppose nuclear power on a variety of grounds. This a view which people are obviously entitled to hold. However, many countries, both advanced and developing, beset with even greater dependence on outside energy sources than the unacceptable level which we now have, place considerably higher priority on nuclear power than we now are. It is an unfortunate fact that many of these countries see U.S. nonproliferation policy as a manifestation of a general opposition to or at best luke-warm support for nuclear energy itself. This perception tends to discredit our nonproliferation policies by making it appear that our real objective is to limit the use of nuclear energy itself.

The third area of disagreement relates to the effectiveness of the existing nonproliferation regime. This regime incorporates many elements, not the least of which is the broad consensus against the proliferation of nuclear weapons which has made their development a generally unacceptable goal of national policy. In more specific terms, the regime depends on assurances by non-nuclear weapons states that they will not misuse civil nuclear activities for nuclear explosives purposes, and the verification of these assurances by the safeguards of the International Atomic Energy Agency. For many years following the initiation of international nuclear cooperation, it was generally believed that if safeguards could be made sufficiently effective technically - that is, if they could detect diversion of significant amounts of material with a high degree of assurance, the consequences of detection would be of such a serious nature that countries would be highly unlikely to attempt it in the first instance, or would be effectively brought back into compliance if they did so.

Much of the recent concern over nonproliferation policy, particularly in the United States, has arisen from a decline in confidence that the regime will function as intended, especially when material directly useable in nuclear explosives is present in a country. It is this concern which led directly to the major changes in U.S. nonproliferation policy calling for indefinite deferral of commercial reprocessing and plutonium recycle, as well as a showdown and restructuring of breeder reactor development. These changes were accompanied by corresponding domestic actions, including the termination of the GESMO proceeding and non-licensing of the Barnwell reprocessing plant, on the basis of the view that the U.S. could not effectively advocate a policy of restraint by others while proceeding with reprocessing and plutonium recycle domestically.

Critics of current U.S. policy point out that no instance of the violation of safeguards has been observed and no nation has developed a nuclear explosive through violation of these arrangements. Proponents of the policy contend that several recent instances in which sensitive facilities have been sought by countries with little apparent need for them provide a legitimate basis for concern, and that the dispersion of sensitive facilities and materials in these circumstances was not the kind of nuclear cooperation which the former policy was designed to deal with.

While its language is carefully qualified, INFCE lends support to the view that the proliferation risks of reprocessing and plutonium are serious, and could be minimized if reprocessing facilities were limited to a few large-scale facilities.

The number and location of reprocessing plants and the use to be made of produced plutonium in the medium range future clearly constitutes one of the principal problem areas of nonproliferation policy. One answer would be to maintain the principle of the past that all steps of the fuel cycle, provided they are undertaken under effective safeguards, should be permitted, particularly if they take place in countries which have accepted the Non-Proliferation Treaty. Another answer would be to apply literally the policy of indefinite deferral of reprocessing and any utilization of plutonium.

If we are to regain the spirit of consensus which long characterized international nuclear cooperation and nonproliferation policy, neither of these extreme outcomes is possible. Reprocessing is taking place today on a limited basis in several countries and will continue to do so. Moreover, reprocessing is an essential step in the breeder reactor fuel cycle, and must be developed and demonstrated on a commercial scale both because its technology is an integral part of breeder technology and because sizeable amounts of plutonium are needed for breeder development and demonstration.

On the other hand, the early dispersal of reprocessing and plutonium to all or most of the countries engaged in nuclear power generation is an equally unattractive and unacceptable outcome of the lengthy debate. Realistically, it is essential that some middle ground be found if a new consensus and a stronger nonproliferation regime are to materialize.

Such a regime might have several elements, which I shall identify later. In the critical area of reprocessing, however, the basic compromise would be to limit reprocessing for the time being to those facilities and activities required in direct support of breeder research, development, and demonstration. This means both the development of an industrial reprocessing base in those countries where breeder development and essential deployment are a logical and foreseeable medium term prospect, and the production of adequate quantities of plutonium for the conduct of breeder development, demonstration and initial deployment.

Such an outcome would not be a facade to disguise unconstrained reprocessing and plutonium use. Its purpose and effect would be to avoid for the foreseeable future reprocessing for the sole purpose of waste management, and for the separation of plutonium for recycle in LWRs. It is these activities which, in effect, would quickly legitimize reprocessing and plutonium utilization, and lead to their early introduction into most or all of the more than 20 countries making use of nuclear power. Confining reprocessing to the countries with genuine need for it in breeder programs, on the other hand, will constitute a real restraint and provide the time needed to develop improved institutional arrangements for the management of plutonium.

INSTITUTIONAL ARRANGEMENTS

INFCE recognized that institutional arrangements were likely to be more effective than technical measures in reducing the proliferation risks of the nuclear fuel cycle. At the same time, it foresaw the development of these arrangements as an evolutionary process which would not reach fruition quickly.

The possibility that sensitive nuclear fuel cycle activities might take place under international or multinational auspices has long attracted nonproliferation policy makers and is an explicit goal of the Nuclear Non-Proliferation Act. However, there is an understandable reluctance on the part of virtually all countries to place complex activities which are difficult enough to perform on a national basis under some form of multinational ownership and management.

Careful examination of the nonproliferation benefits of multinational arrangements leads to the conclusion that the principal element in these benefits is multinational custody and control of the movement of sensitive materials. There is no reason in principle why this feature cannot be achieved even at facilities whose ownership, management and operation remain under national control. Such arrangements should be far more acceptable to countries than those which interfere with conventional modes of ownership and operation, while preserving most of the nonproliferation benefits usually associated with more ambitious schemes. At the same time, this custody approach would not rule out more ambitious arrangements for multinational ownership, if this were of interest to particular groups of countries, and it could well be an evolutionary step toward such arrangements.

A limited application of the concept of international custody is now the subject of detailed discussions by an Expert Group of the International Atomic Energy Agency. This Group is exploring the implementation of a provision of the IAEA Statute which authorizes the Agency to require the deposit with the Agency itself of plutonium which is excess to current requrirements. The U.S. attitude toward this arrangement has been a somewhat ambivalent one. On the one hand, concern has been expressed that such an arrangement will prematurely "legitimize" plutonium. On the other hand, there has been recognition that plutonium is being and will continue to be produced and that storage of this material under IAEA custody is preferable to its accumulation in national hands.

There is no reason in principle why an international plutonium storage regime cannot be formulated in a way which approximates for plutonium the overall custody arrangement suggested earlier in this testimony. A narrow international plutonium storage arrangement - one which is confined to excess plutonium in the narrowest sense of the word and which allows the release of this material with a minimum of subsequent control or verification of immediate need might not offer a sufficiently important nonproliferation benefit to offset its weaknesses.

Is the possibility of taking a bold and innovative step forward in institutional arrangements, such as placing sensitive materials and facilities under international or multinational custody, too visionary to be considered seriously? There is no compelling reason why such a step should be impossible. In reality, it represents no greater advance beyond the safeguards-based nonproliferation regime of the present than safeguards were beyond the vacuum which they filled. In the area of institutional arrangements as in most other aspects of nonproliferation policy, U.S. leadership will be the key factor. Unless the United States is prepared to indicate what it wants and what it is willing to offer in return, progress will be impossible.

SAFEGUARDS

INFCE also identifies safeguards as a more effective means than technical measures for reducing proliferation risks.

The development of an international system, based on on-site inspection, for the verification of nonproliferation undertakings constitutes a major achievement in international relations, which hopefully will have application some day far beyond the immediate area of nonproliferation. The Agency safeguards system as it has evolved to date is a serious, professional undertaking that exposes any nation which seeks to divert material to a real risk of detection. Criticism that this system is imperfect all too often misses the point that it represents a solid achievement that is still undergoing improvement.

Despite the progress made, safeguards, particularly for complex facilities which handle weapons useable material in bulk form, are a difficult task-probably more so than earlier recognized. There is no simple answer to how safeguards should be applied to large and complex facilities. A variety of methods including both materials accountability and containment and surveillance will undoubtedly be necessary. Despite the utility of instruments, the role of the human inspector will remain critical and, for many purposes, will continue to be the most cost-effective measure available. Improved technology, improved cooperation on the part of inspected parties, and expanded resources will all be necessary if the IAEA is to maintain and improve its standards for future applications.

If these achievable improvements are made, there is no reason to doubt that sensitive facilities can be safeguarded effectively; that is, with a high degree of assurance that any significant diversion will be detected or suspected. However, most of the concerns associated with safeguards in current U.S. nonproliferation policy relate in reality to another issue which is primarily political in nature, this issue is what consequences would flow from a detected violation of safeguards. As observed earlier in this testimony, it was primarily the concern that diverted plutonium could be transformed into nuclear explosives which gave rise to current U.S. nonproliferation policy. Whether the transformation time following a diversion is long or short, what will be the consequences of a detected diversion remains a critical issue which has received less attention than it deserves.

An important step in the right direction was taken in the Presidential nonproliferation policy statement of October 1976, which called for strong reaction to any violation of nonproliferation undertakings. The process of seeking a highly visible consensus on the unacceptability of violations of nonproliferation undertakings should be accelerated and strengthened.

U.S. POLICY

More than three years has passed since the basis of current U.S. nonproliferation policy was announced in April 1977, and more than two years since the adoption of the Nuclear Non-Proliferation Act of 1978. Little purpose would be served by reviewing the widespread expressions of concern and dismay which these two actions first elicited. Of far greater importance are recent policy trends.

international reactions to these, and what future steps are needed to build on the foundation of INFCE and help assure a new and strengthened nonproliferation consensus.

Time permits identifying only a few aspects of current U.S. nonproliferation policy:

- Export Licensing and Fuel Assurances

No principle was recognized earlier and was more important to the development of the current nonproliferation regime than the need to provide dependable fuel supply assurances to other countries. Such assurances were provided for in the Atomic Energy Act of 1954 and in its administration, and were the essential quid pro quo for securing agreement to safeguards, adherence to the Nonproliferation Treaty, and restraint for many years in the development by other countries of independent enrichment capacity. It was only when the United States began to impose its enrichment monopoly with too heavy a hand, while concurrently taking actions that created doubt as to the reliability of its assurances and the adequacy of its capacity that other nations began seriously to consider the need for independent sources of supply.

Given this background, it is disturbing and surprising that current U.S. policy, in particular the Nuclear Non-Proliferation Act of 1978 contains elements which undermine the credibility of U.S. fuel assurances and gives foreign customers legitimate cause for concern whether U.S. fuel supply commitments will be met.

In fairness, it must be acknowledged that the NNPA embraces the principle of reliable fuel assurances and includes several concrete provisions which represent improvements over the chaotic situation which prevailed before adoption of the Act. Nevertheless, the Nuclear Non-Proliferation Act has, in effect, codified and elevated to policy status what had begun as a de facto practice of employing the export licensing process as a means for an assessment of the suitability of each particular nuclear export, a role which it was never intended to fulfill. In so doing, the Act has understandably been viewed both within and outside the U.S. as a major obstacle to the restoration of the credibility of supply assurances which is essential to any new nonproliferation consensus. In examining the validity of this criticism, an important distinction which is often overlooked must be made between those requirements which apply only to new arrangements and those which are retroactive in nature. The right of any nation to modify its unilateral policies, however wise or unwise these modifications may be, is indisputable. The concept that new conditions can be placed on existing undertakings is a different matter, and raises fundamental issues of equity, propriety, and even legality. Perhaps more importantly from the viewpoint of its impact on the nonproliferation regime, it is destructive of one of the fundamental bases of nonproliferation policy - the expectation by recipients that supply commitments will be honored if they remain in full compliance with their undertakings.

While many of the new requirements of the Non-Proliferation Act are entirely prospective in application, and therefore not properly subject to the criticism of unilateralism and retroactivity, there are, unfortunately, a few provisions which have the effect of placing new requirements on existing undertakings. It is a puzzling anomaly that the Act embraces the principle of reliability of supply in several general provisions, yet contains specific provisions which make it difficult or impossible for administrators to meet the general requirement.

The effect of the retroactive conditioning of supply assurances has been pervasive. Where, as a result of many years of painstaking care to meet all supply commitments, it was once taken for granted that these undertakings could be depended on, it is now being taken for granted that no supply commitment can be relied upon. The proposition is advanced that a sovereign country will always be in a position, with or without legal excuse, to disregard commitment which it believes to be contrary to its national interest.

It is, perhaps, a truism that an international undertaking can be abrogated, just as a domestic contract can be violated. There is a vast distintion, however, between an environment in which governments feel constrained to honor their commitments in all but the most extreme circumstances, and one in which they feel free to disregard them at will. The former provides a basis, just as domestic contracts do, for arrangements in which parties are willing to depend on outside sources of supply for even critical goods and services. The latter insures that independent development will occur.

While the process will be long and painstaking, the former presumption of reliability can and must be restored. A renewed history of reliable performance is essential to this process, but words on paper can also help. Legislation which adopts as national policy the fulfillment of supply obligations to all who comply with their own obligations can do much to reassure U.S. customers of U.S. supply credibility. The elevation of supply undertakings to treaty status is another way in which the dependability of these commitments could be strengthened. The application of penalties to nations which violate supply undertakings is another possibility which deserves consideration.

In a somewhat different category from retroactivity is the problem of case-by-case consideration of export licensing and related actions. The requirement for case-by-case approval which, as noted earlier, was introduced by regulatory fiat well before the Non-Proliferation Act was adopted is not necessarily in conflict with the principle of inviolability of supply assurances, ofprovided the requirement is not introduced retroactively, and the recipient is aware of and has agreed to its application. The question remains whether it is sound nonproliferation policy. A requirement for case-by-case licensing is fundamentally inconsistent with the long-term supply reliability which recipients must enjoy if the development of independent sources of supply is to be constrained. The uncertainty of case-by-case review is compounded when responsibility for export determination is delegated to a body which is independent of the Chief Executive, and, indeed, of the Congress as well.

These difficulties have led many to conclude that nothing short of major amendments to the Nuclear Non-Proliferation Act will suffice. While amendments to the Act are clearly desirable, it seems unlikely that these will be forthcoming in the immediate future. Thus, it is important to seek improvements which can be accomplished by steps short of legislation.

The complexity of the Act itself suggests that considerable progress could be made through more flexible and affirmative administration, particularly in an atmosphere of Congressional sympathy and support. Recent trends in adminsitration are positive and should be given all possible encouragement. In the final analysis, however, only a complete and legislatively endorsed abandonment of the principle of retroactive application of new export conditions will suffice to restore to U.S. fuel assurances the credibility which they once enjoyed.

- Prior Consent

A major issue in current bilateral and multilateral nuclear policy negotiations is the right, sought by the U.S. and several other nuclear suppliers, to exercise approval over the reprocessing of nuclear fuel which they have supplied. At first glance, intense debate on this issue - usually referred to as "prior consent" -

may seem somewhat surprising in light of the fact that "prior consent" has been incorporated in most U.S. agreements from the very outset of international nuclear cooperation, and is found as well in the Statute of the IAEA. The debate becomes more understandable, however, when it is recognized that, in recent years, the right of prior consent has begun to be exercised in a manner not foreseen when these provisions were incorporated into bilateral agreements. In many respects, the exercise of these rights has taken on the same retroactive and case-by-case characteristics which have been applied to initial exports themselves. Where the criterion foreseen by Agreements for Cooperation for reprocessing approval was the effectiveness of the safeguards to be applied, the NNPA unilaterally specifies a new criterion of no significant increase in proliferation risk, with timely warning of diversion a foremost consideration in making this determination. Only the grandfather provisions of the Act, coupled with generally flexible and understanding implementation by the Administration has avoided what could well have been irreparable damage to U.S. nuclear relationships arising from these provisions.

Nevertheless, time is running out on the ad hoc accommodations which have been reached to date. Under the pressure of the negotiation of new agreements, also dictated by the NNPA, and the intention of several countries to construct reprocessing facilities not covered by the "grandfather" provisions of the NNPA, a new and far more predictable policy for dealing with reprocessing approvals is needed. The policy suggested earlier of endorsing reprocessing associated with breeder research, development, and demonstration could provide the basis for this predictability.

- Full-Scope Safeguards

Among the provisions of the NNPA is one which requires that safeguards be in force on all nuclear materials and equipment in a country as a condition of export licensing. This provision included a two year grace period, which has now expired. Although exceptions could be made by the President, subject to Congressional review and possible disapproval, such exceptions would obviously have to be few and far between.

The concept of full-scope safeguards is one which has broad support in the nuclear community both domestically and abroad, although several important suppliers have so been unwilling to adopt it. There is relatively little opposition in the U.S. to its adoption as a general policy applicable to new commitments in the future. Its application to existing contracts and commitments, however, raises once again the issue of retroactivity. It is unfortunate that U.S. nuclear supply commitments are no longer sufficiently attractive to others that we must seek to place new conditions on existing commitments to achieve a worthwhile policy objective such as full-scope safeguards.

- Renegotiations

The NNPA also requires that the U.S. take the initiative in renegotiating essentially all of its existing agreements, in order to seek incorporation of broader rights of prior consent over reprocessing, full-scope safeguards and similar provisions. This process is underway and the negotiation of several agreements has been completed, and the texts presented for Congressional review. It is noteworthy that the negotiations completed to date have been largely with parties which already have similar policies to that of the United States, and which are predominantly suppliers to the U.S. rather than recipients of U.S. nuclear materials and equipment. In particular, Agreements with Australia and Canada have been negotiated, under which the U.S. has agreed to reciprocal rights of prior consent. Since both Australia and Canada are expected to be important suppliers of natural uranium for U.S. nuclear power generation, it is obvious that this reciprocity is not simply academic.

The negotiation of agreements with countries which are primarily recipients of U.S. nuclear materials and equipment has, predictably, proven to be far more difficult and no important negotiation in this category has been completed. The reasons for this are worth examining. These fall into two categories: the inherent unattractiveness of the U.S. negotiating positions, in particular that relating to prior consent; and the inability of the United States to offer an attractive quid pro quo in exchange for acceptance of these inherently unappealing policies. It is this latter difficulty in particular, which requires a better understanding.

Perhaps no single factor has more distorted the U.S. nonproliferation debate in recent years than the mistaken belief held by many that the U.S. continues to enjoy some form of negotiating leverage which, if only exercised vigorously enough, could bring about the acceptance of almost any U.S. nonproliferation policy. Such a state of affairs, if it ever existed, has long since faded, partly as a result of U.S. actions themselves in stimulating independent sources of supply; partly as a result of the inevitable advance in technological capability by others. Ironically, the very fact that the demand for nuclear power has declined so drastically in recent years - a development which many nonproliferation policy critics have also favored and encouraged - has hastened the decline in U.S. negotiating leverage.

Fortunately, this state of affairs does not mean that the U.S. has no ability to reach agreement on policies which reflect, in a reasonable way, the legitimate concern with the unconstrained spread of sensitive facilities and materials. Its ability to reach these agreements, however, calls for approaches other than the heavy handed application of a non-existent negotiating leverage.

While the world of international negotiation is not a notably sentimental one, the United States still possesses an enormous reservoir of good will in the nuclear area as a result of its prior willingness to share this advanced technology with its allies and partners. This background will not in itself ensure the acceptance of U.S. positions, but, at a minimum, it can and should ensure that the negotiations take place in an atomosphere of open-minded and constructive search for a mutually acceptable outcome. Despite the strains of recent times, the totality of U.S. relationships in nuclear cooperation should rule out any petulance and rigidity on both sides. The fact that other countries share a genuine concern over the risks of further proliferation, even if they do not always share U.S. views on how to avoid this danger, provides a common ground for negotiations.

Beyond this, success in reaching a new nonproliferation consensus, both bilaterally and on a broader multilateral basis clearly requires U.S. leadership. In a sense, the U.S. started this debate, and only the U.S. can end it. This means that we must indicate clearly what we will agree to and what we are willing to concede in return. Above all, we must make it absolutely clear that the understandings which are reached in this round of negotiations will be lasting ones, and that we will not seek to raise the ante once again when new actors express new concerns. Only our past cooperation has made possible this present reassessment. There is little reason to believe that another round will be open to us in the future. The Congress can do much to create the climate which will make the present discussions successful.

Finally, the U.S. position will be greatly strengthened by a strong domestic program of research, development, and demonstration which keeps the United States in the forefront in every important area of nuclear power development. Our domestic capability has always been the basic trading card in achieving our international nuclear objectives, including international consensus on a strong and effective nonproliferation policy. Our friends abroad, far from seeking to limit our competition, have strongly urged us to retain our leadership role in nuclear development.

CONCLUSION

I should like to conclude this presentation by returning to a theme expressed earlier.

The goals of full utilization of nuclear power and of nonproliferation are not conflicting; on the contrary they are and can continue to be mutually reinforcing. Countries which place heavy reliance on nuclear power have a vested interest in insuring the continuity of their supplies and the overall viability of the nuclear option, interests which would clearly be compromised if they were to engage in nuclear explosive activities.

It follows that opposition to nuclear power is not simply an ineffective nonproliferation tool; it is a counter-productive one. Those who advocate retrenchment or abandonment of nuclear power along with rigid restraints in the name of nonproliferation cast doubt on their own motives and are ineffective advocates for nonproliferation.

The energy challenge which we face provides a renewed opportunity to revitalize both nuclear power and the nonproliferation regime.

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
SUITE 2321 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, D.C. 20515

June 11, 1980

Mr. Myron Kratzer
International Energy
  Associates, Ltd.
600 New Hampshire Ave., N.E.
Suite 600
Washington, D. C. 20036

Dear Mr. Kratzer:

Thank you once again for appearing before the Subcommittee on Energy Research and Production during our June 5 hearing on the International Nuclear Fuel Cycle Evaluation study, and the implications for future nuclear energy research and development. We found your testimony particularly insightful and useful, and we sincerely appreciate you sharing your expertise with us.

During the hearing, we indicated that the Subcommittee might request some additional information in the form of further questions. Having reviewed the testimony received at the hearing, we find that additional information would be very helpful. Accordingly, we would appreciate your providing, for the record, responses to the enclosed questions.

Your prompt reply would be most appreciated. Thank you for your cooperation on this matter.

Sincerely,

MIKE McCORMACK, Chairman
Subcommittee on Energy
Research and Production

MM/Cwm

Enclosure

QUESTIONS FOR
Mr. Myron Kratzer
following
INFCE HEARINGS
June 5, 1980

1. In an effort to obtain a concensus, much of what is in INFCE is highly qualified and non-judgmental. What were some of the frequently expressed views of the delegation to the final plenary session which reflect directly on current U.S. policy?

2. What have foreign delegations indicated the impact of INFCE and a continuation of current U.S. policy will have on their nuclear policies, including cooperative R&D programs with the U.S.?

3. A frequent theme of the INFCE delegation was the important relationship between the acceptance of stringent non-proliferation conditions and assured nuclear supplies. Do these delegations perceive that adequate assurance can be provided by the U.S. without an aggressive U.S. development program of breeder reactors and reprocessing?

4. What is the linkage between how we deal with reprocessing in this country and our ability to restrain reprocessing abroad?

5. Do we really strengthen our hand by not operating Barnwell? Or is that simply regarded as naive by our partners?

6. What was behind President Ford's statement on reprocessing in 1976?

   What was the Frye report? What did it say? What happened to it?

7. INFCE emphasized political preventatives to proliferation and de-emphasized technological solutions. What do you think are the implications of this for U.S. nuclear RD&D and what roles do you see for improved nuclear technology in controlling proliferation?

8. The NNPA attaches great importance to timely warning as a prerequisite for U.S. reprocessing approvals. With two years hindsight, how important does timely warning appear to be now?

INTERNATIONAL
ENERGY
ASSOCIATES
LIMITED

June 27, 1980

Mr. Gordon Chipman
Committee on Science
  and Technology
Rayburn House Office Building
Suite 2321
Washington, D.C. 20515

Dear Gordon:

Enclosed is my response to the additional questions following INFCE hearings. I have sent my corrections to be made in my testimony to Stephen Lanes.

Sincerely yours,

Myron

Myron B. Kratzer

MBK:vfp

Encl.

ANSWERS TO QUESTIONS FOR
Mr. Myron B. Kratzer
following
INFCE HEARINGS
June 5, 1980

1. I have not had an opportunity to review the record of the final Preliminary Session of INFCE but in my contact with foreign officials, I believe the key points are the importance of the breeder reactor; the necessity of much more reliable fuel assurances particularly from the U.S., as the most important supplier; and the necessity of allowing countries to pursue fuel cycle policies which are in keeping with their own national energy needs and priorities. INFCE strongly rejected the proposition that all countries should be deprived of the importance of nuclear energy options because of legitimate proliferation concerns arising out of the actions of a very few countries.

2. More and more countries, particularly the industrialized countries of Japan and Western Europe, who are our closest allies and partners, are indicating that in the absence of U.S. cooperation they will make other arrangements to meet their needs for both research and development and nuclear supply. There is still considerable interest in cooperation with the U.S., but this is no longer regarded as a necessity by our friends abroad.

3. There is a long term relationship between U.S. development of breeder and reprocessing and its ability to provide reliable fuel assurances. Many foreign countries feel strongly that with its still impressive technological capability, the U.S. has both an opportunity and an obligation to contribute to the development of these important technologies and there is no doubt that a strong U.S. contribution would put us in a much better position to gain

acceptance of our nonproliferation policies. In the shorter run, reliable fuel assurances must be based on a reversal of the current U.S. attitude that it is permissible to impose new nonproliferation conditions on existing fuel supply commitments.

4. There is a linkage between how we deal with reprocessing in this country and our ability to restrain it in unstable locations abroad. However, this linkage is a much more complex matter than the simplistic theory that by not reprocessing in the United States we necessarily strengthen our ability to restrain reprocessing elsewhere. For example, we were extremely successful for a number of years in restraining enrichment abroad, not by foregoing enrichment in the United States, but by exactly the opposite approach - by reliably fulfilling all legitimate requirements for enrichment services.

   Similarly, there is a demand both for reprocessing to meet legitimate plutonium requirements for breeder research and development and to meet the need for a viable reprocessing technology that forms a part of the breeder reactor fuel cycle. To the extent that these legitimate requirements are not fulfilled, the pressure for reprocessing around the world will be increased. Reprocessing in the United States as well as in other locations where reprocessing makes technological and economical sense can help restrain reprocessing elsewhere if it takes place as part of a general consensus on a new nonproliferation regime.

5. If conducted in support of breeder R&D, the operation of Barnwell can reinforce the lesson that reprocessing is an acceptable activity only for limited purpses, such as support to breeder reactor research and development. Such operation could also provide a valuable test bed for institutional development, including improved safeguards,

multinational custody and international plutonium storage. However, without making clear the limited purposes of the operation could imply weakening of the U.S. desire to restrain the spread of reprocessing to sensitive locations, and, thus, detract from U.S. efforts toward this end.

6. President Ford's October 1976 Statement was an attempt to deal with the issue raised by the spread of reprocessing facilities to parts of the world that were viewed as unstable from the standpoint of proliferation risks. These efforts began in 1975 by the establishment, at U.S. initiative, of the London Suppliers Group. The original U.S. objective was to restrain reprocessing in sensitive locations and considerable success was achieved in this effort as indicated by the London Supplier Guidelines under which all major nuclear suppliers agreed to exercise restraint in the transfer of sensitive technologies; the specific undertaking of the French and German governments to refrain from any further reprocessing transfers "for the time being"; and the Korean decision not to construct a French supplied reprocessing plant. There was no intention whatsoever to attempt to roll back reprocessing either in the U.S. itself or in countries which had a legitimate reason to proceed with reprocessing.

The effort, however, was not entirely successful, as indicated by continued plans for reprocessing plants in Pakistan and Brazil, and the spread of reprocessing became a political issue in the Presidential campaign of 1976. Thus, President Ford ordered a further review of the issue in the summer of 1976. Mr. Robert Fri, then Deputy Administrator of ERDA, was designated to undertake this review. He was assisted by a small number of individuals from ERDA and the Department of State.

His report, which was completed in the early fall of 1976, was classified since among other reasons, it contained options for Presidential review and decision. However, its principal recommendations were made public in the form of President Ford's October 1976 nonproliferation policy statement. This statement advanced the principle that there is a link between U.S. domestic reprocessing policy and the policies of other countries and the U.S. ability to influence these policies. It concluded, therefore, that reprocessing and plutonium recycle should no longer automatically be regarded as an inevitable part of the light water reactor fuel cycle and that commercial reprocessing should be deferred until more was learned of the proliferation hazards of plutonium. Toward that end, it called for a reprocessing evaluation program. However, the statement specifically called for continued R&D on the breeder since the decision on commercialization of the breeder was some time away. The possible impact of the policy on the operation of Barnwell was not specified. In the view of some, Barnwell operation might take place as part of the reprocessing evaluation program.

In some respects the October 1976 Statement was a forerunner of the April 1977 policy statement. However, the 1976 statement did not call for indefinite deferral of commercial reprocessing. Instead, its tone was positive, implying that reprocessing would be resumed when appropriate steps were taken to deal with the proliferation risk of plutonium. The emphasis was on learning how to do this through the reprocessng evaluation program, not on employing alternative fuel cycles.

Since it was issued only a few days before the U.S. elections of 1976, the Ford statement attracted very little attention either domestically or abroad. While it has been viewed by some as a step toward the policy adopted by the Carter Administration in April 1977, its more limited proposals were clearly superceded by the present policy.

7. The INFCE finding that there is no technical fix to the nuclear fuel cycle and that such fuel cycles as thorium/U-232 offer little or no nonproliferation advantages should help clear the air, allowing U.S. nuclear RD&D to proceed along the mainstream of world nuclear energy R&D which emphasizes the plutonium fueled LMFBR. At the same time there are some technological adjustments to the fuel cycle which, while not panaceas, can help control proliferation risk. These include: co-processing, improvement of the light water reactor fuel utilization efficiency, and the development of improved isotope separation techniques to allow more efficient use of uranium resources. In addition, improvements in the technology of safeguarding, particularly for sensitive facilities such as reprocessing plants, is an obvious area in which research and development can contribute to the reduction of proliferation risk.

8. The basic criterion of the NNPA relating to reprocessing is that it should "not result in a significant increase of the risk of proliferation beyond that which exists at the time that approval is requested." This criterion is a logical one. There is no doubt that "timely warning" is an appropriate factor to be considered in applying the basic criterion of "no increase of proliferation risk", but it is equally clear that undue emphasis on "timely warning" can actually defeat the effective application of the basic criterion. For example, rejection of reprocessing under limited and controlled circumstances, such as for breeder R&D, could lead to decisions by other countries to develop independent reprocessing capacity and to avoid the requirement for U.S. approval by using non-U.S. sources of nuclear fuel and equipment, which are readily available. Such an outcome would clearly increase proliferation risks, not reduce it.

The emphasis of the NNPA on timely warning appears to be overstated for other reasons as well. The opportunity to penalize nonproliferation violations, or to seek corrective action, does not automatically come to an end when a country has exploded a nuclear device, as U.S. policy toward the Indian explosion clearly demonstrates. The difficulty which countries or subnational groups which divert nuclear materials would face in developing and manufacturing nuclear explosives has probably been seriously underestimated in the nonproliferation leading up to the NNPA, and this matter deserves much more careful attention than it has received. To the extent, however, that the NNPA creates the impression that this step is a simple one, its importance as part of the proliferation "process" is actually reduced, and it should not be viewed as the end of the road in taking corrective action in the event that diversion is detected.

It is unfortunate and contrary to U.S. nonproliferation objectives to imply, as undue emphasis on "timely warning" tends to, that diversion which is followed by development of a nuclear explosive has been a successful one, and nothing further can be done about it. In general, U.S. nonproliferation policy would benefit from less emphasis on controlling the fuel cycle activities of the vast majority of countries which will honor their nonproliferation undertakings, and greater emphasis on how to deal with situations where violations of these undertakings have taken place or are threatened.

Mr. McCormack. Thank you.

Mr. Kratzer. Yes.

Mr. McCormack. At this point let me ask one more question for clarification.

Mr. Kratzer. Yes.

Mr. McCormack. I've tried to work this out, but you pointed out that 30 percent advantages in reprocessing. This is obviously for fission material. What about the balance of the uranium in the system? You are sitting there with all the uranium resources tied up with spent fuel and you do not have enough material to make new fuel with. This is irregardless of your physical inventory.

Can you please comment on that?

Mr. Kratzer. Mr. Chairman, my recollection is that the savings in plutonium recycle represents about 30 percent in the amount of uranium that has to be mined. It is true that the only thing that plutonium recycle gives you is the fissionable material, but because of the ratios of fissionable material present in fresh uranium to that present in light water reactor fuel—well, my understanding is that 30 percent is the gain that it gives you.

Mr. McCormack. Is this the controlling factor overall, Mr. Kratzer?

Mr. Kratzer. I think it could be. I acknowledge that there could come a day when there is a gap between uranium supply and demand. I don't think that we are close to that day at the moment. I repeat, I don't claim there are no penalties in what I have outlined. All that I claim is that if you are looking for an area of compromise, it seems to me this is the area. It doesn't mean the plutonium recycling should not be studied. It doesn't mean that there shouldn't be plutonium recycle development work against the day when this gap might indeed appear; that is, when you don't yet have a viable breeder technology in being, but you are running low in uranium, meaning its price is getting beyond the economic level. I do think that we can put it off for a while.

Mr. McCormack. Thank you.

Mr. Kratzer. That is all that I am saying here, Mr. Chairman. Thank you.

Mr. McCormack. Please continue.

Mr. Kratzer. Institutions are an area to consider. I have believed for some time that this is an area that deserves a great deal of emphasis and study as a means for reducing the proliferation risks. I would like to put it in these terms: If an objective of nonproliferation policy is to minimize or avoid national access to sensitive materials, then we have two ways of doing that. One of them is to eliminate the sensitive material, the so-called technical fix. We've reached the conclusion that is not going to happen.

The other way is to eliminate the national access. The way you try to do that is to put the sensitive facilities or materials under some kind of international or multinational control. You put them into international or multinational hands. The objections to that are many. I think that the principal objections to that over the years have been, first of all, that these are difficult activities. They are hard enough to do under presumably efficient national management. If you try to do them under the management of a number of countries, they simply are not going to work very well.

In addition, the countries that are engaged in that kind of thing will lose some of their energy independence or autonomy. They will not be able to make the same purely national decisions on the fuel cycle as they might otherwise be able to do.

I believe that there are ways to get most of the benefits of international or multinational "auspices"—as the Nonproliferation Act terms it—without going all the way to international ownership or management. One way by an arrangement that I term "custody," in which the essential nonproliferation benefit, which is the control over the movement of sensitive material in and out of the facility, is really placed, not simply under international surveillance, but under international or multinational control. This leaves the management, operation, and ownership in conventional national hands. This could mean either private or governmental, depending on the system of the particular country involved.

There is the IPS, the international plutonium storage that we have heard a great deal about here today. It is, in effect, on a selective or limited basis, an example of the custody arrangement. It is quite often referred to in that way. When we talk about international storage, no one is talking about the IAEA becoming the owner of that plutonium or even of the facility in which it would be stored, but of having a bona fide control over its release to permit its use. So, I believe the possibility that this kind of a scheme can be developed is a real one.

Safeguards themselves are an important form of institutional arrangement. I think those that have developed the safeguard systems—I won't say they are heroes—deserve credit for a rather remarkable development.The system is not just on paper, but it is in being. These very important nonproliferation undertakings are being verified by an international team. It is not a perfect system. It is one that will require a great deal of attention and resources that it doesn't have right now, but it is real. It does expose countries that would violate their commitments to a real risk of detection .

I think that safeguards can be made effective enough to give you a high degree of assurance that the diversion from even difficult plants, such as reprocessing plants, will be detected.

Finally, Mr. Chairman, I have outlined what I think might emerge. Let me touch on what I think might be the necessary conditions for that to occur. I think, clearly, the most important condition is U.S. leadership. We have been the leaders in nonproliferation policy in the past. I don't say that other nations are not serious in their interest in nonproliferation, but, for a variety of reasons, that leadership can only come in the future from the same place that it has come from in the past, that is, the United States.

I think that we have to clearly correct the very unfortunate situation in which our reliability as a supplier has been cast into doubt. We have to find a way to give reliable fuel assurance. We have to make it crystal clear to countries that when we enter into the fuel supply commitments, they will be honored as long as the other party honors its obligations.

Finally, I think it is absolutely clear that we only have one more chance at this. We simply cannot get agreement on a new nonproliferation regime if other countries think that 5 or 10 years from now a new group will come along in the United States and say, "That's not good enough. We have to do it over again." This is really our last chance.

I think, clearly, that we have to maintain and strengthen our leadership in all areas of nuclear technology. That has been our strength in the past. I think it has to be reestablished if we are going to be able to bring about these difficult, but, I think, achievable understandings for the future.

Mr. Chairman, pardon me for taking so long. This concludes my comments.

Mr. McCormack. Thank you.

Now we have about 9 minutes before we have to vote, Mr. Kratzer.

Mr. Kratzer. Yes.

Mr. McCormack. Do you wish to ask any questions at this time, Mr. Lundine, or come back and ask them?

Mr. Lundine. I can ask my questions later.

Mr. McCormack. Do you mind if we vote at this time and then come back?

Mr. Kratzer. No; I don't mind.

Mr. McCormack. We will stand in recess for a few minutes at this time.

[Short recess.]

Mr. McCormack. The subcommittee will now be back in order.

Now, I have several questions that I would like to ask, Mr. Kratzer.

Mr. Kratzer. Yes.

Mr. McCormack. I'd like to review some points that you made so that we can understand each other.

I would like to ask you if I understand you correctly when you say that with respect to the linkage between the civilian nuclear power and weapons fabrication that you recognize that this is not impossible, but that other techniques for obtaining weapons materials are probably easier, cheaper, more efficient weapons, and they are more easily hidden.

Could you comment on that? Would this be a fair statement?

Mr. Kratzer. I think that is correct, Mr. Chairman. I think that the basic question is what is the starting point. If you are talking about a country with industrial and technological capability, but without a nuclear powerplant or program, as such, and deciding today that it wants to have nuclear weapons or nuclear explosives, then there is no question they would choose something other than the nuclear power fuel cycle. They would get what they want more quickly and more cheaply by dedicated facilities, small dedicated facilities.

On the other hand, if you postulate a country which has a nuclear power industry in being with all or part of the fuel cycle——

Mr. McCormack. With the separations.

Mr. Kratzer. Presumably the worst case. I think that is what Dr. Starr said this morning. A nuclear power industry with the entire fuel cycle. Then it may very well be tempted to make that the basis of a nuclear weapons program.

There is an argument, and I don't think that you can dismiss it, that if a country had the complete fuel cycle, then the political decision, and there has to be a political decision to go for nuclear weapons, will come more easily. I don't think that you can entirely dismiss that argument.

Mr. McCormack. The response to that is to attempt to provide some sort of multinational control over reprocessing facilities or the other facilities where there might be access to weapons materials that could be used at the time for weapons, Mr. Kratzer.

Mr. Kratzer. Yes. We have international assurance through the safeguards that are required. We have the NPT also. But if you are looking for another level of assurance for the most sensitive activities, then I think that multinational controls are clearly where you go.

Mr. McCormack. If you have that with coprocessing, then at no time producing materials that could be used in weapons, and this would reduce the potential for diversion.

Mr. Kratzer. That's correct, especially as to the subnational threats, because they are less able to deal with the problem of separating the material.

Mr. McCormack. Did INFCE, to your knowledge, treat the growing threat of proliferation that would evolve from the new technologies for the isotopic separation of uranium-235 from naturally pure uranium?

Mr. Kratzer. It dealt with that in a limited degree. It was handicapped, as I understand it, because of the fact that much of this technology remains classified, including that of the new laser separation. Thus, they had very little to base a judgment on.

They did, however, look at the relative proliferation risks of the better known processes. There is the centrifuge and diffusion, and I believe the chemical exchange process which had been proposed, and they reached, I don't know whether it was an agreed conclusion, but some consensus as to the relative risks of the process.

Mr. McCormack. Do you believe they should have looked more carefully at the more advanced separations or separation process, Mr. Kratzer?

Mr. Kratzer. Yes. I believe that we could have made more information available on the risks of the advanced processes without crossing a line that we properly should not cross, Mr. Chairman.

Mr. McCormack. And other technologies. There is the German and South African technology.

Mr. Kratzer. Yes. I think that there is enough information on them in the public domain to be fairly clear on their proliferation risks. I think the consensus is that they stand somewhere between the centrifuge and the fusion process.

Mr. McCormack. Thank you.

Mr. Kratzer. Yes.

Mr. McCormack. The next point that I would like to ask you about is this. Apparently it does not represent an internal inconsistency in your testimony, but there are those that might consider it as such. I would like to see if we can resolve it, Mr. Kratzer.

Mr. Kratzer. Yes.

Mr. McCormack. You said, I believe, that since breeders require reprocessing, that we need an industrial scale demonstration of reprocessing for breeder fuels. You also said that, since reprocessing may be marginally economically feasible, we may be able to reach a meaningful compromise by doing without the reprocessing to mix the fuel for the LWR.

Mr. Kratzer. I may have said that. I meant to say that plutonium recycle in light water reactors is marginally economic. Therefore, to reprocess for that purpose only, this is not a convincing reason to do so. But you do need to reprocess. The only thing available to reprocess in any quantity at the moment happens to be light water fuel.

Mr. McCormack. You're saying that we need an industrial scale reprocessing facility demo plant if only in connection with the breeder program?

Mr. Kratzer. That's right. It is needed.

Mr. McCormack. You are saying that we may be able to do without reprocessing of plutonium or recycling of plutonium for the purpose of making the mixed oxide fuels on an economic basis for the light water reactors?

Mr. Kratzer. Yes.

Mr. McCormack. To add the third ingredient, how does the question of plutonium inhibition come in as far as reprocessing all or most light water fuel? As you recall, there have been statements made, and I believe one of the conclusions of INFCE was that the storage of spent fuel was the least environmentally acceptable as an option because it essentially or inevitably created plutonium mines of the whole spent fuel. This created its own hazard.

To put it another way, one way you and I have agreed would be to reduce the potential for proliferation or a diversion of material is to have fuel reprocess at some multinational center. So, this becomes an added factor in that consideration as to whether or not we should be reprocessing fuel. So, it is more than just an economic question of recycling plutonium for the light water reactors. It is a question of whether or not we should be reprocessing fuel for the purpose of reducing the potential for proliferation.

Mr. Kratzer. That is right. I think that the proliferation risks of spent fuel accumulation, given the fact that plutonium becomes more accessible as time goes on, is a real issue.

I agree with what Dr. Starr said this morning. There comes a point in time when the best thing to do with plutonium from the standpoint of proliferation is to burn it up. The difficulty in dealing with these questions, and I think it is a considerable one here, is that there is always a question of compared to what?

If you are talking about a given country, just say country X, with an inventory of plutonium in spent fuel form, then I think that you have to concede it is less of a proliferation risk than is an inventory of separated plutonium of equal size. This is regardless of what country it is. So, you really have to be saying, Mr. Chairman, not simply that you will reprocess plutonium in order to avoid the plutonium mines, because separated plutonium is a somewhat better plutonium mine than is spent fuel.

You also have to say where you are going to reprocess. In other words, is it going to remain in the country or is it going to go to presumably some more acceptable location; also under what kind of regime is that reprocessing going to happen, and under what kind of a regime are you going to store excess plutonium if there is any excess? I think that these are difficult questions. The one thing that you do know is that, because they will take a certain period of time to answer such questions and to get more effective nonproliferation regimes into being, it probably makes sense not to quickly have a lot of reprocessing around the world and a lot of separated plutonium unconnected with the really high priority objectives, such as breeder research and development.

Mr. McCormack. Reprocessing in a weapons state with multinational management.

Mr. Kratzer. That would be ideal.

Mr. McCormack. A mix of institutional and technical controls.

Mr. Kratzer. It is hard to argue that is not the ideal from the standpoint of proliferation risk reduction.

Mr. McCormack. You mentioned plutonium storage a couple of times.

Mr. Kratzer. Yes.

Mr. McCormack. Let me ask you also about that.

Mr. Kratzer. Yes.

Mr. McCormack. Is it fair to say that the optimum plutonium storage would be as a new fuel so that, again, it is not in the form that it is usable for weapons without reseparation?

Mr. Kratzer. Yes.

Mr. McCormack. Go ahead.

Mr. Kratzer. I do think that, here, again, there is an issue of compared to what? I can visualize a case where a stockpile, even though an international one, of fabricated plutonium fuel in a particular location, was somewhat more troublesome from a standpoint of proliferation risk than a stockpile of separated but unfabricated plutonium in a more stable location. So, I think it is also necessary to look at what you are comparing it against. However, I would say the ideal solution, and I don't think this is inachievable, and this is encompassed in what I was talking about in the word custody, is that you really do both.

In other words, wherever there is a sizable stock of separated plutonium, whether it is in unfabricated form or fabricated form, I believe, ideally, that should be under the international plutonium storage and management regime.

Mr. McCormack. I want to thank you very much for your testimony.

Mr. Kratzer. Thank you.

Mr. McCormack. I was particularly touched by your conclusion that this is our last chance for U.S. leadership. I am deeply concerned. I share your concern for the need for U.S. leadership. I share your concern with the fact that our credibility in the world has been seriously eroded. I hope that we don't blow our last chance.

Thank you. I hope that your testimony, and that of the others before these hearings, will help do this.

Mr. Kratzer. Thank you.

Mr. McCormack. Our final witness is Dr. John Lamarsh, who is head of the department of nuclear engineering at the Polytechnic Institute of New York. He has been a consultant on nuclear nonproliferation matters to a number of Government offices and agencies, as well as a consultant on nuclear matters to U.S. and foreign utility companies.

We are looking forward to your testimony from an academic viewpoint on the implications of INFCE.

Dr. Lamarsh. Thank you.

Mr. **McCormack**. At this time we have your prepared testimony before us.

Dr. **Lamarsh**. Yes.

Mr. **McCormack**. Without objection, your testimony will be included in its entirety in the record.

STATEMENT OF DR. JOHN R. LAMARSH

Dr. **Lamarsh**. Thank you, Mr. Chairman.

A good deal of the material in my testimony has already been covered by previous speakers.

Mr. **McCormack**. Yes.

Dr. **Lamarsh**. I will therefore just hit the highlights, if I may.

Mr. **McCormack**. You certainly may. I want to commend you for staying here so long and listening to the other speakers. It must have been very difficult for you to wait.

Dr. **Lamarsh**. Mr. Chairman, I welcome this opportunity to express my views on current U.S. nonproliferation policy, the outcome of the INFCE exercise and its implications for future R.D. & D. efforts of the Department of Energy.

Let me say at the outset that I am not in sympathy with the bulk of recent or present U.S. nonproliferation policy.

The concern of the present administration over nuclear weapons proliferation certainly is commendable. It continues the tradition of previous administrations, going back to World War II. But I am afraid the recent twists and turns in U.S. policy have not eliminated the threat of nuclear proliferation and, in the long run, may actually have exacerbated the problem. I think that you made that point yourself.

I would like to begin by recalling an important fact that is often lost in discussions on nonproliferation policy. That is, that it is not inordinately difficult for virtually any nation in the world, except the most primitive, to manufacture a small nuclear arsenal in a relatively short time following the initiation of a serious nuclear weapons program.

What this means is that it is fundamentally impossible to prevent the proliferation of nuclear weapons by any sort of national or international policy short of occupying an offending nation.

At the same time, this is no excuse for delivering ready-made weapons technology abroad.

The impending use of plutonium in developing countries led to the adoption of our new nonproliferation policies. It was felt, and I feel properly, that encouraging the use of plutonium by all nations, and providing the technology for its production was tantamount to delivering weapons technology abroad. So, in an effort to prevent countries like South Korea, Taiwan, and Brazil from reprocessing their power reactor fuel, the administration took the totally irrelevant step of placing a ban on the reprocessing of our own power reactor fuel, while we continued to operate the world's largest reprocessing plants for the sole purpose of producing plutonium for nuclear weapons.

In short, commercial reprocessing was unacceptable; military reprocessing was acceptable, at least in the United States.

Having dispensed with commercial reprocessing, it was necessary to drop the breeder reactor, since reprocessing is a vital part of the breeder fuel cycle.

At the same time, the President proposed the INFCE program. Speaking at the first organizing conference on INFCE in October of 1977, the President made it clear that plutonium breeders should be banned throughout the world, and that the nuclear fuel cycle should be "fixed" by some sort of new technology to reduce its proliferation potential.

The INFCE exercise has been concluded, and, while members of the administration may not agree, INFCE, in fact, was a resounding defeat for the United States. I won't repeat the conclusions of INFCE. They have been covered by the previous speakers.

In any case, INFCE always seemed to me to have a kind of dream world character about it. How anyone could have supposed that a country like France, which has invested billions in its breeder program, would precipitously drop the breeder on the strength of vague arguments about weapons proliferation in a handful of developing countries that could get weapons in any case if they really wanted them was entirely beyond my comprehension.

France, which is almost entirely lacking in indigenous fossil fuels, has enough depleted uranium on hand today to meet its electrical needs for the next 100 years when this uranium is used in breeder reactors. France could not possibly have been expected to give up the breeder.

What is more, the adoption of any of the complex new fuel cycles proposed by the United States never had a chance, in my opinion. They were very popular in academic circles after 1976, but the adoption of those fuel cycles was entirely out of the question. Decades are required to commercialize any new reactor type, and such a redirection of the world's struggling nuclear industry was entirely out of the question as a practical matter.

Now, one important concept that has emerged from INFCE is that of the international and multinational fuel cycle centers. A great deal has already been said about these centers at these hearings.

I think that the matter of spent fuel storage is especially important. This material is accumulating in spent fuel pools around the world. The plutonium in this fuel represents a very real threat of weapons proliferation, since it is not that difficult to reprocess the fuel and fabricate bombs.

President Ali Bhutto of Pakistan made it clear after his fall from power that it had been his intention to obtain nuclear weapons by such diversion of plutonium from his country's peaceful nuclear power program. There are undoubtedly groups in other developing countries who look upon their spent fuel as a potential source of nuclear weapons material.

Now, while it is true that power reactor fuel is not ideally suited for weapons use, and that nations can produce more satisfactory weapons material via dedicated facilities outside the commercial fuel cycle, the fact remains that spent fuel provides an ongoing, inplace nuclear weapons resource.

As I said earlier, there can be no justification for freely distributing weapons technology abroad. It is important, therefore, in my opinion, that the spent fuel be removed from spent fuel pools around the world. Exactly how this should be done is a political matter of some sensitivity. The Soviets merely insist that spent fuel from reactors located in satellite nations be returned to the Soviet Union. Whether, in the non-Communist world, international or multinational fuel cycle centers of the type discussed in INFCE are practical is highly problematical, in my view. It seems to me that international institutional arrangements, even of a regional nature, tend to be politically complicated, inherently unstable and necessarily ephemeral.

The world map is continually changing, and so are the relations among nations. Governments come and go, and the obligations of one may not be honored by another.

What is more, international arrangements usually require lengthy negotiations. I think the removal of spent fuel cannot wait on the conclusion of such negotiations. And fuel cycle centers have to be located somewhere. Consider the Far East, for example. Where would we put a storage facility to handle the spent fuel generated in that region? When a facility was proposed on Palmyra Island in the South Pacific, Australia and other countries raised objections. Why would Canada accept spent fuel, except perhaps from its own Candu reactors? And why, for that matter, should Japan ship its spent fuel out of the country simply for storage. I do not think that Japan would stand for this for a moment. The cost of transportation of spent fuel is enormous. Japan has realistically evaluated its long range energy needs, and has developed a plutonium fueled reactor, the Fugen, and the LMFBR, along with the necessary reprocessing capability to obtain some degree of energy independence.

Until a year or so ago we might have thought of Iran as an ideal location for a fuel cycle center. Iran was a stable, strong, forward-looking country, a pillar of stability in a strife-ridden region, with its own very considerable nuclear program. What would have been the fate of an international fuel cycle center located in Iran today?

While I have little confidence in international regulatory arrangements, I believe strongly in the vigor of international commerce, especially where the goods have inherent value as does spent fuel.

For example, the energy content of the spent fuel from only one refueling of a nominal 1,000 megawatts electrical PWR plant is equivalent to about 1 million tons of coal. Instead, therefore, of trying to establish a supranational political structure to regulate spent fuel storage, I would be inclined to treat spent fuel merely as an item of commerce.

None of the responsible leaders in developing countries, with the exception of those with weapons ambitions, needs or wants the hassle of the continuing management of their spent fuel.

The United States and other nuclear supplier nations should therefore undertake to buy back the spent fuel wherever it exists, at a handsome price, if necessary, and store it pending reprocessing and the consumption of its contained plutonium in one type of reactor or another.

Japan, for example, might very well purchase spent fuel from Taiwan and South Korea. The transportation costs to Japan would be minimal. Instead, therefore, of attempting to dissuade Japan from operating their Tokai-mura pilot reprocessing plant and building their larger commercial plant, the United States should encourage Japan to operate these facilities, and to build Fugen and breeder reactors in order to consume the extracted plutonium. Needless to say, we should get on with comparable programs ourselves, as I shall relate momentarily.

With regard to future nuclear R.D. & D., in the United States in the light of INFCE, I believe there is no reason, certainly no proliferation-related reason, why we should not proceed with the development of the breeder reactor.

The other major industrial nations in the world, especially France and the Soviet Union, all have substantial breeder programs, and we are falling rapidly behind in this technology.

I should like to point out that there is a strong parallel between the present faltering of U.S. breeder technology and the beginning of the demise of the American merchant marine during the last century. The United States had pioneered in the development of steamships in the early part of that century, but the technology was rapidly adopted and exploited by Europe. In part because of U.S. Government policy, foreign steamships increasingly dominated the seas throughout the latter half of the 1800's, and, by the beginning of World War I, when we desperately needed ships, our merchant marine was virtually nonexistent.

I also see no reason, in light of INFCE, why we should not resume the GESMO hearings on reprocessing. Whether it makes economic sense to recycle plutonium and uranium in LWR's is an open question at this point. Nevertheless, it is clear that the reprocessing of spent fuel significantly reduces the problems associated with radioactive waste disposal. It seems generally agreed that spent fuel cannot be disposed of in a manner which will satisfy IOCFR part 60 unless it is first reprocessed.

With regard to waste disposal, I think it is regrettable that after years of study and restudy of this issue, we still have no plans to build even a pilot waste facility. I believe we should begin immediately to design and build such a facility based on most recent technology. This would not be a monumental undertaking. If, for some reason, it proved unsatisfactory, the waste could simply be moved to a new and improved facility. But if we keep waiting for the perfect technology we will never build anything. I think there is a good chance our waste will all have decayed away by the time we get around to doing anything about it.

We should also attempt to repair our ties with the major industrialized nations: France, the Federal Republic of Germany, the United Kingdom and others in breeder and related nuclear technology. These nations see us as erratic, unreliable, and totally unpredictable. We should make every effort to regain the confidence of our former technological partners.

I would like now to make a few comments regarding the developing country energy assessment program under the direction of DOE's Office of International Affairs. The original objective of this program was to assess the energy needs and resources of developing countries in the hope that nonnuclear energy alternatives could be identified.

However, studies of several Third World nations have revealed that nuclear power is their only realistic energy option. These nations need assistance in initiating nuclear power programs.

DOE should look into the design of small nuclear powerplants in perhaps the 250 megawatt electrical range, provide for training of manpower in the United States, and so on.

In this connection, I should point out that the People's Republic of China has undertaken a modest civil nuclear power program. While China is not exactly a developing country in the usual sense, it lags the world in peaceful nuclear technology by years, if not by decades, and seriously needs help from abroad.

The United States, in particular, is in a unique position to assist China with its nuclear program. Such assistance would provide another link in the friendly relations between our two countries and, from our own point of view, would tend to assure the continued input of U.S. nuclear technology within the Chinese economy for years to come. There is no issue here of proliferation. China has had the bomb for years.

At the same time, however, aid to China need not be given gratuitously, without some quid pro quo. What I have in mind is the fact that China has not signed the Non-Proliferation Treaty and is the only nation in the world that continues to test weapons in the atmosphere. I believe we should attempt to negotiate an attractive assistance package with China, in exchange for China's adherence to NPT and its renunciation of atmospheric testing. Perhaps it could not be done, but I believe it is worth a try. I have discussed this matter with people in the State Department and in the Department of Energy, Mr. Chairman, with no success.

With the banning of reprocessing and the breeder here at home, with the unsuccessful attempt to turn the international nuclear community topsy-turvy with INFCE, and with the antinuclear bias of the developing country energy assessment program, the present U.S. administration appears clearly and firmly antinuclear abroad.

Simultaneously, the administration and the Congress have sought to establish in the Nuclear Non-Proliferation Act of 1978, that the United States will forever be a reliable supplier of nuclear reactors and fuel to the world. I have never been able to comprehend the sequence of logic involved here. How can we advertise ourselves as a reliable supplier of the world's lollipops if, at the same time, we go on a campaign to get the world to stop eating sugar?

Current nonproliferation policy has succeeded only in reducing U.S. influence in nuclear affairs abroad. We have essentially no input to nuclear technology in South America. Mexico will not even buy the fuel for its two American reactors directly from this country, and there is every reason to expect that future Mexican reactors will be French; and Canada has a very successful nuclear program of its own. Japan is building its own reactors, the People's Republic of China and Hong Kong are together looking to France for a proposed jointly owned nuclear plant; and Korea is moving in the direction of France instead of the United States for KECO's units 9 and 10, at least in part because of U.S. Government policies. Our influence over European nuclear affairs is at rock bottom as evidenced by the overwhelming European rejection of U.S. proposals in INFCE.

In conclusion, Mr. Chairman, let me say that it is extremely easy to be discouraged about U.S. technology these days.

In the wake of Three Mile Island, the DC-10 and our helicotpers in Iran, it may very well be that American technology is not the marvel that we once thought it was. Perhaps the administration is correct in handing over our world leadership in nuclear technology to France. I suppose, in time, the United States can get used to the idea of being a second or third rate technological power.

But I think that we still have a chance to reestablish the greatness of this Nation in technology, nuclear technology in particular, if we can somehow put this unfortunate, pseudomoralistic period behind us and get on with satisfying the energy needs of a growing and developing world.

Mr. Chairman, I apologize. That was not quite as abbreviated as I had expected it to be.

[The prepared statement and additional questions and answers of asked of Dr. Lamarsh follows:]

Statement
by
John R. Lamarsh
before the
Subcommittee on Energy Research and Production
of the
Committee on Science and Technology
U. S. House of Representatives
June 5, 1980

My name is John R. Lamarsh. I am Head of the Department of Nuclear Engineering at the Polytechnic Institute of New York. I have been a consultant on nuclear nonproliferation matters to the Congressional Research Service, the Office of Technology Assessment, the General Accounting Office, and most recently I have consulted with the National Science Foundation on the reorganization of the Nuclear Regulatory Commission. I have also acted as a consultant to the Korea Electric Company, the Pennsylvania Power and Light Company, and a number of other organizations.

I welcome this opportunity to express my views on current US nonproliferation policy, the outcome of the INFCE exercise and its implications for future RD and D efforts of the Department of Energy. Let me say at the outset that I am not in sympathy with the bulk of recent

US nonproliferation policy. While the concern of the present Administration over nuclear weapons proliferation is commendable and continues the tradition of previous Administrations dating back to the end of World War II, the recent twists and turns of US policy have not eliminated the threat of nuclear proliferation and in the long run may actually have exacerbated the problem.

I

I would like to begin by recalling the important fact, often forgotten in discussions of nonproliferation policy, that it is not inordinately difficult for virtually any nation in the world, except the most primitive , to manufacture a small nuclear arsenal in a relatively short time following the initiation of a serious nuclear weapons program. What this means is that it is fundamentally impossible to prevent the proliferation of nuclear weapons by any sort of national or international policy short of occupying an offending nation. At the same time, this is no excuse for delivering ready-made weapons technology freely about the globe.

It was the impending use of plutonium in developing countries which alarmed the nonproliferation community in the United States and led to the adoption of our new nonproliferation policies. It was felt, properly I believe, that encouraging the use of plutonium by all nations and providing the technology for its production was tantamount to delivering weapons technology abroad. So in an effort to prevent countries like South Korea, Taiwan, and Brazil from reprocessing their power reactor fuel, the Administration took the totally irrelevent step of placing a ban on the reprocessing of our own power reactor fuel, while we continued to operate the world's largest reprocessing plants for the sole purpose of producing plutonium for nuclear weapons. In short, commercial reprocessing was unacceptable; military reprocessing was acceptable, at least in this country.

Having dispensed with commercial reprocessing it was necessary to drop the breeder reactor, since reprocessing is a vital part of the breeder fuel cycle. At the same time, the President proposed the INFCE program to re-evaluate nuclear fuel cycles in an attempt to arrive at a less proliferating system than one based on reprocessing, recycle and the breeder. Speaking at the first organizing INFCE conference in October 1977, the President made it clear that plutonium breeders should be banned throughout the world, and that the nuclear fuel cycle should be "fixed" by some sort of new technology to reduce its proliferation potential.

The INFCE exercise has been concluded, and while members of the Administration may not agree, INFCE, in fact, was a resounding defeat for the United States. Thus the participants determined that none of the technical alternatives proposed by the United States were any more proliferation resistant than conventional reactors and fuels. Indeed, INFCE could not even establish whether the US policy of storing spent fuel without reprocessing is more or less proliferation resistant than reprocessing the fuel and recycling the plutonium. INFCE delegates also emphasized that plutonium breeders represent the most viable mechanism by which many countries can reduce their dependence on imported fuels. What is more, INFCE predicted an ultimate shortage of uranium fuel for use in ordinary non-breeder reactors if breeders are not rapidly introduced in the more highly industrialized nations.

From the start, INFCE seemed to me to have a kind of dream world character about it. How anyone could have supposed that a country like France, which has invested billions in its breeder program, would precipitously drop the breeder on the strength of vague arguments about weapons proliferation in a handful of developing countries, that could get weapons in any case if they really wanted them, has always been beyond my comprehension. France, which is almost entirely lacking in indigenous fossil fuels, has enough depleted uranium on hand today to meet its electrical needs for the next 100 years when this uranium is used in breeder reactors. France could not possibly have been expected to give up the breeder.

What is more, the adoption of any of the complex new fuel cycles proposed by the United States never had a chance, in my opinion. Decades are required to commercialize any new reactor type, and such a redirection of the world's struggling nuclear industry was entirely out of the question as a practical matter.

II

One important concept which has emerged from INFCE is that of international or multinational fuel cycle centers. Presumably one or all of the sensitive parts of the nuclear fuel cycle could be located at such centers: spent fuel storage, fuel reprocessing, plutonium storage, and so on. I think the matter of spent fuel storage is especially important. This material is accumulating in spent fuel pools at reactors around the world. The plutonium in this fuel represents a very real threat of weapons proliferation, since it is not that difficult to reprocess the fuel and fabricate bombs. President Ali Bhutto of Pakistan made it clear after his fall from power that it had been his intention to obtain nuclear weapons by such diversion of plutonium from his country's peaceful nuclear power program. There are undoubtedly groups in other developing countries who look upon their spent fuel as a potential source of weapons material.

While it is true that power reactor fuel is not ideally suited for weapons use, and that nations can produce more satisfactory weapons material via dedicated facilities outside the commercial fuel cycle, the fact remains that spent fuel provides an on-going, in-place nuclear weapons resource. As I said earlier, there can be no justification for freely distributing weapons technology abroad. It is important, therefore, in my opinion, that the spent fuel be removed from spent fuel pools around the world.

Exactly how this should be done is a political matter of some sensitivity. The Soviets merely insist that spent fuel from reactors located in satellite nations be returned to the Soviet Union. Whether in the non-communist world, international or multinational fuel cycle centers of the type discussed in INFCE are practical is highly problematical, in my view. It seems to me that international institutional arrangements, even of a regional nature, tend to be politically complicated, inherently unstable and necessarily ephemeral. The world map is continually changing, and so are relations among nations. Governments come and go, and the obligations of one may or may not be honored by its successor. What is more, international arrangements usually require lengthy negotiations.

And fuel cycle centers have to be located somewhere. Consider the Far East, for example. Where would we put a storage facility to handle the spent fuel generated in that region? When a facility was proposed on Palmyra Island in the South Pacific, Australia and other countries raised objections. Why would Canada accept spent fuel, except perhaps from its own CANDU reactors? And why, for that matter, should Japan ship its spent fuel out of the country simply for storage? I do not think they would stand for that for a moment. The cost of transportation of spent fuel is enormous. Japan has realistically evaluated its long range energy needs, and has developed a plutonium fueled reactor, the Fugen, and the LMFBR, along with the necessary reprocessing capability to obtain some degree of energy independence.

Until a year or so ago we might have thought of Iran as an ideal location for a fuel cycle center. Iran was a stable, strong, forward-looking country, a pillar of stability in a strife-ridden region, with its own very considerable nuclear program. What would have been the fate of an international fuel cycle center located in Iran today?

While I have little confidence in international regulatory arrangements, I believe strongly in the vigor of international commerce, especially where the goods have inherent value as does spent fuel. For example, the energy content of the spent fuel from only one refueling of a nominal 1000 MWe PWR plant is equivalent to about one million tons of coal. Instead, therefore, of trying to establish a supranational political structure to regulate spent fuel storage, I would be inclined to treat spent fuel merely as an item of commerce.

None of the responsible leaders in developing countries, with the exception of those with weapons ambitions, needs or wants the hassle of the continuing management of their spent fuel. The US and other major nuclear nations should therefore undertake to buy back spent fuel wherever it exists, and store it pending reprocessing and the consumption of its contained plutonium in one type of reactor or another. Japan, for example, might very well purchase spent fuel from Taiwan and South Korea. The transportation costs to Japan would be minimal. Instead, therefore, of attempting to dissuade Japan from operating their Tokai-Mura pilot reprocessing plant and building their larger commercial plant, the United States should encourage Japan to operate these facilities, and to build Fugen and breeder reactors in order to consume the extracted plutonium. Needless to say, we should get on with comparable programs ourselves, as I shall relate momentarily.

III

With regard to future nuclear RD and D in the United States in the light of INFCE, I believe there is no reason -

certainly no proliferation-related reason - why we should not proceed with the development of the breeder reactor. The other major industrial nations in the world, especially France and the Soviet Union, all have substantial breeder programs, and we are falling rapidly behind in this technology. I do not subscribe to the view expressed by DOE administrators that "the United States can always buy breeder reactors from France." French breeder technology is excellent; I have nothing but admiration for French nuclear technology. But breeders were first developed in the United States, and I see no reason why we should be reduced to importing them from abroad. We already import too much technology which had its origins in this country. There is also no reason to suppose that breeders will actually be available from France when we need them, at a price we would be willing to pay, or that the French breeder will be licensable in the United States. What is more, France could be behind the iron curtain twenty years from now.

I should like to point out that there is a strong parallel between the present faltering of US breeder technology and the beginning of the demise of the American merchant marine during the last century. The United States had pioneered in the development of steamships in the early part of that century, but the technology was rapidly adopted and exploited by Europe. In part because of US Government policy, foreign steamships increasingly dominated the seas throughout the latter half of the 1800's, and by the beginning of World War I, when we desperately needed ships, our merchant marine was virtually non-existant.

I also see no reason, in light of INFCE, why we should not resume the GESMO hearings on reprocessing. Whether it makes economic sense to recycle the plutonium and uranium in LWR's is an open question at this point. Nevertheless, it is clear that the reprocessing of spent fuel significantly reduces the problems associated with radioactive waste disposal. It seems generally agreed that spent fuel cannot be disposed of in a manner which will satisfy 10CFR Part 60 unless it is first reprocessed.

With regard to waste disposal, I think it is regrettable that after years of study and re-study of this issue we still have no plans to build even a pilot waste facility. I believe we should begin immediately to design and build such a facility based on most recent technology. This would not be a monumental undertaking. If, for some reason, it proved unsatisfactory, the waste could simply be moved to a new improved facility. But if we keep waiting for the perfect technology we will never build anything. I think there is a good chance our waste will all have decayed away by the time we get around to doing anything about it.

We should also attempt to repair our ties with the major industrialized nations: France, the Federal Republic of Germany, the United Kingdom and others in breeder and related nuclear technology. These nations see us as erratic, unreliable, and totally unpredictable. We should make every effort to regain the confidence of our former technological partners.

IV

I would like now to make a few comments regarding the developing country energy assessment program under the direction of DOE's Office of International Affairs. The original objective of this program was to assess the energy needs and resources of developing countries in the hope that non-nuclear energy alternatives could be identified. However, studies of several third world nations have revealed that nuclear power is their only realistic energy option. These nations need assistance in initiating nuclear power programs. DOE should therefore revise its generally negative position regarding nuclear power in developing countries and undertake a positive program to help these countries with their nuclear energy needs. In particular, DOE should look into the design of small nuclear power plants in perhaps the 250 MWe range, provide for training of manpower in the United States, and so on.

In this connection, I should point out that the People's Republic of China has undertaken a modest civil nuclear power program. While China is not exactly a developing country in the usual sense, it lags the world in peaceful nuclear technology by years, if not by decades, and seriously needs help from abroad. The United States, in particular, is in a unique position to assist China with its nuclear program. Such assistance would provide another link in the friendly relations between our two countries and, from our own point of view, would tend to assure the continued input of US nuclear technology within the Chinese economy for years to come. There is no issue here of proliferation; China has had the bomb for years. At the same time, however, aid to China need not be given gratuitously, without some quid pro quo. What I have in mind is the fact that China has not signed the Non-Proliferation Treaty and is the only nation in the world that continues to test weapons in the atmosphere. I believe we should attempt to negotiate an attractive assistance package with China, in exchange for China's adherence to NPT and its renunciation of atmospheric testing. Perhaps it could not be done, but I believe it is worth a try.

V

With the banning of reprocessing and the breeder here at home, with the unsuccessful attempt to turn the international nuclear community topsy-turvy with INFCE, and with the antinuclear bias of the developing country energy assessment program, the present US Administration appears clearly and firmly antinuclear abroad. Simultaneously, the Administration and the Congress have sought to establish in the Nuclear Non-Proliferation Act of 1978 that the United States will forever be a reliable supplier of nuclear reactors and fuel to the world. I have never been able to comprehend the sequence of logic involved here. How can we advertise ourselves as a reliable supplier of the world's lollipops, if, at the same time, we go on a campaign to get the world to stop eating sugar?

Current nonproliferation policy has succeeded only in reducing US influence in nuclear affairs abroad. We have essentially no input to nuclear technology in South America; Mexico will not even buy the fuel for its two American reactors directly from this country, and there is every reason to expect that future Mexican reactors will be French; and Canada has a very successful nuclear program of its own. Japan is building its own reactors, the People's Republic of China and Hong Kong are together looking to France for a proposed jointly-owned nuclear plant; and Korea is moving in the direction of France instead of the United States for KECO's units 9 and 10, at least in part because of US Government policies. Our influence over European nuclear affairs is at rock bottom as evidenced by the overwhelming European rejection of US proposals in INFCE.

VI

It is easy to be discouraged about US technology these days. In the wake of Three Mile Island, the DC-10 and our helicopters in Iran, it may be that American technology is not the marvel we once thought it was. Perhaps the Administration is correct in handing over our world leadership in nuclear technology to France. I suppose, in time, the United States can get used to the idea of being a second or third rate power.

But I think we still have a chance to reestablish the greatness of this nation in technology, nuclear technology in particular, if we can somehow put this unfortunate, pseudo-moralistic period behind us, and get on with satisfying the energy needs of a growing and developing world.

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June 11, 1980

Dr. John R. Lamarsh
68 N. Chatsworth Avenue
Larchmont, New York 10538

Dear Dr. Lamarsh:

Thank you once again for appearing before the Subcommittee on Energy Research and Production during our June 5 hearing on the International Nuclear Fuel Cycle Evaluation study, and the implications for future nuclear energy research and development. We found your testimony particularly insightful and useful, and we sincerely appreciate you sharing your expertise with us.

During the hearing, we indicated that the Subcommittee might request some additional information in the form of further questions. Having reviewed the testimony received at the hearing, we find that additional information would be very helpful. Accordingly, we would appreciate your providing, for the record, responses to the enclosed questions.

Your prompt reply would be most appreciated. Thank you for your cooperation on this matter.

Sincerely,

Mike McCormack

MIKE McCORMACK, Chairman
Subcommittee on Energy
Research and Production

MM/Cwm

Enclosure

best copy available

QUESTIONS FOR
Dr. John Lamarsh
following
INFCE HEARING
June 5, 1980

1. One popular phrase in current use is "international plutonium management". What is your understanding of its meaning? How practicable an idea do you think it is?

2. How feasible do you think is the proposition that the U. S. could cut back its breeder development costs by entering into cooperative arrangements with other countries?

   What would this do for U. S. technological leadership?

3. How important is nuclear technological leadership for the U. S.? Is it worth the cost of regaining it?

4. Dr. Hans Bethe has recently publically acknowledged that he believes we should proceed with the development of Clinch River. He has come to this view because he no longer believes the design to be obsolete, because INFCE concluded there is no substantial proliferation difference between LMFBR and advanced converters, and because it is prudent engineering to include an intermediate demonstration facility before taking the step to full size. What are your views on Clinch River? Is it an obsolete design?

5. What do you think of the idea that the world inventory of plutonium can be reduced and minimized by using breeders as plutonium burners? To some, this seems a contradiction in terms.

6. Nuclear Power for developing countries.

   a. Can developing countries be trusted to operate one or two nuclear power plants safely, or would supplying them with nuclear plants buy another TMI situation?

   b. If developing countries are to use nuclear power, could there be some kind of commercial or international reactor operating service to provide good engineering and technical backup?

7. Several years ago you did two studies for the Congressional Research Service that indicated the comparative ease with which smaller countries could produce weapons quantities of plutonium independently of nuclear power facilities and materials. Has your experience since then led you to change any of your conclusions?

8. With Three Mile Island more than a year behind us, do you see any indications that proliferation is becoming more of a public issue than nuclear safety?

JOHN R. LAMARSH
68 NORTH CHATSWORTH AVENUE
LARCHMONT, NEW YORK 10538

914-834-8576

June 20, 1980

Dr. Stephen Lanes
Staff Director
Committee on Science and Technology
Room B 374, Rayburn Building
U.S. House of Representatives
Washington, D.C. 20515

Dear Dr. Lanes:

In response to Mr. McCormack's letter of June 11, 1980, I am enclosing a corrected transcript of my testimony and my replies to his questions.

Please let me know if I can be of any further assistance.

Sincerely yours,

John R Lamarsh

John R. Lamarsh

JRL:bg

enclosure

Replies to Questions
following
INFCE Hearing
June 5, 1980

John R. Lamarsh

1. My understanding of the term "international plutonium management" is that it refers to the storage, distribution or disposal of separated plutonium in or by facilities operated under the aegis of some sort of international organization. This organization presumably could consist of all nations within a given region of the world or a subset of these nations having spent fuel which has been reprocessed or which is to be reprocessed for eventual use in thermal recycle or in a breeder reactor.

   I do not believe that "international plutonium management" is either necessary or practical. First of all, plutonium storage facilities will have to be put somewhere, and, as I have said in my prepared testimony, this raises serious questions of the changing relations among nations and the stability of the host country. There is also the issue of establishing criteria and guarantees for the release of plutonium to its country of origin. I cannot believe that any responsible foreign government leader would agree to storing his nation's plutonium in the United States, for example. In the past few years this country has lost all credibility in nuclear affairs, having unilaterally abrogated countless nuclear agreements including the Non Proliferation Treaty. No nation sending its plutonium to the United States has any reason to expect that it will ever get it back. Far better, in my opinion, than the concept of international plutonium management is the simple buy-back of spent fuel by major supplier/breeder nations. Once spent fuel is removed from the spent fuel pools of non-nuclear weapons states, the problem of proliferation via the commercial fuel cycle will be largely solved.

2. If this question refers to the possibility of building breeders in the United States that are designed abroad or based on foreign designs, then I am not in favor of the idea. In my opinion, the breeder, at least the LMFBR, is a developed device, to the extent that railroad trains and steamboats were developed in the first half of the 19th century and airplanes were developed by the beginning of World War I. All that we need to do is to build some LMFBR's and gain practical experience with their operation as other major industrialized nations are doing.

   Where we made our big mistakes in developing the LMFBR was first, in not supporting the operation of Fermi 1, and second, in opting for a continuation of Government-sponsored research and development via the FFTF instead of proceeding with the immediate construction of a demonstration plant, as industry tried unsuccessfully to convince the AEC to do. We should, of course, to the extent possible, enter into cooperative arrangements with the more advanced breeder nations in areas of safety, design and economics. I believe we already have some agreements of this sort. But I do not see how this will have much of an effect on the overall development cost of the breeder in the United States, in view of the costs already incurred for the FFTF, the cost of the stalled Barnwell plant, and the escalating cost of Clinch River.

I do not believe that the United States is now a leader in breeder technology, certainly not in plant operating experience. Cooperation with other countries can help to keep us in the field.

3. Regaining leadership in nuclear technology is vital to the continued security of the United States and to the well-being of its citizens. As events unfold on the international scene, we can reasonably expect to see ourselves increasingly isolated from the rest of the world. It does not appear entirely unlikely to me that in the near future additional portions of the Mideast, Africa, Latin America and the Far East will fall under Soviet domination. Much of Western Europe could be behind the Iron Curtain in the next decade or so. If this occurs, it will be crucial for the continued existence of

our nation that we be able to meet our energy needs from indigenous resources, and this, in particular, means nuclear energy.

4. I would hardly call Clinch River obsolete. The original design of the plant is only six or seven years old, and it has been continually updated since that time. For example, during 1976-1977, the containment structure was re-designed so that the plant can now withstand a full hypothetical core disruptive accident. The core was also re-designed to be heterogeneous rather than homogeneous. This is accomplished by interchanging several rows of fuel and blanket assemblies. A heterogeneous core has several advantages over a homogeneous core: a higher breeder ratio, increased control rod worth, more uniform flux and power distributions, and so on. This represents a modern approach to breeder core design, which I believe will also be utilized in SuperPhenix. I also understand that since TMI, a detailed failure mode analysis has been made on Clinch River and, except for minor changes indicated by the analysis, the design was shown to be sound.

5. Breeders can be operated in such a way that they produce either more or less plutonium than they consume. Breeders can therefore be used as plutonium burners. However, this is a wasteful procedure since these reactors could be producing

more of an energy resource, namely, plutonium. In any event, since breeders produce plutonium at a slower rate than LWR's, the world inventory of plutonium will increase more rapidly if we continue to build LWR's than if we build breeders. Of course, plutonium can also be consumed in LWR's via recycle and in any other type of reactor, for that matter. The Japanese have developed a reactor they call Fugen, which is specifically designed to burn plutonium.

6. (a) Many developing countries fly American-made jets - Boeing 747's, DC 10's, etc. - not only over their cities but over our own. Yes, I think developing countries can be trusted with nuclear plants. But many of these countries would be advised to buy smaller plants than those now offered by US manufacturers.

   (b) I believe it would be an excellent idea to have some sort of commercial or international organization to assist developing countries with emergencies. I do not understand why Westinghouse or General Electric have not sought to establish such an organization on their own, without Government prodding, and before an emergency occurs.

7. I believe the conclusions of my reports for the Congressional Research Service regarding the production of plutonium via dedicated facilities are essentially correct today. However, more recent studies at Oak Ridge National Laboratory suggest that the reprocessing of spent fuel from either production or power reactors may actually be easier to carry out than I had indicated.

8. I do not think that proliferation has ever been as serious a public issue as reactor safety. I also do not see proliferation becoming more of an issue in the future. In view of the shortcomings of the present Administration's nonproliferation policies, which are becoming more obvious every day, and with the failure of the Administration to achieve its objectives in the INFCE exercise, I doubt that proliferation will remain a central issue during the next four years if the present Administration is returned to office in November. On the other hand, if a new Administration is elected, I also doubt that proliferation will be an important issue, although it would be left with a terrible mess to clean up.

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Mr. **McCormack.** Thank you for an extraordinarily concise statement.

Dr. **Lamarsh.** Thank you.

Mr. **McCormack.** I am sure that all the members of the committee will very much appreciate what you have said.

As I listened to you make your statement, I made notes. I simply came up with very few questions. It is mostly where there were remarks on agreement concerning what you said. I have three questions, I think.

In your suggestion that we simply treat the spent fuel as a commodity in the free industrial or commercial world, I wonder what you think about somehow attempting, at least, to provide some situation where you trade new fuel for the old, or try to establish this attraction to the nations that we hope would not be involved in reprocessing?

Dr. **Lamarsh.** I think that is a fine idea. I think the point, instead of attempting to handle our relations with the foreign nuclear countries with a stick, that we should do it with a carrot, that this is important. I think that we have been attempting to over-regulate our foreign nuclear programs and nuclear programs in foreign countries. Any effort that will make it attractive, whether it be our purchase of the fuel, or exchange of new fuel with foreign countries or developing countries, I would support that, certainly. I think, in effect, they are equivalent. There would be the question of negotiations. It might be worth our while to spend—and when I said a handsome price—we might pay for more than the energy content of spent fuel if we were that interested in nonproliferation.

There is a group in Korea that wants to develop nuclear weapons. There is another group that does not. If we really don't want them to develop nuclear weapons, we can put a dollar value on it. Then we could purchase the fuel, that is, if we really mean this.

Mr. **McCormack.** We might pay them enough to set up a dedicated system to make the weapons.

Dr. **Lamarsh.** That is true. There is absolutely nothing that we can do about that.

Mr. **McCormack.** My comment was, of course, facetious.

Dr. **Lamarsh.** Yes.

Mr. **McCormack.** I should observe, so nobody will be overly enthusiastic, that you commented about the waste disposal demonstration facilities that we had authorized in this committee.

Dr. **Lamarsh.** Yes.

Mr. **McCormack.** I only wanted to caution that we will have this only if the bill becomes law.

Dr. **Lamarsh.** Yes.

Mr. **McCormack.** I would not say that we should hold our breath until that time. I hope that we can persuade the administration to support the concept and the legislation.

There are two questions. One is this. Dr. Hans Bethe recently publicly had written to the committee that we should proceed with the development of Clinch River. He did this because of a statement, an ad lib statement he had made at a public meeting here in this room—it being consistently misrepresented—he did this because of the updating of the design and because of the INFCE decision or conclusion that there was no substantial proliferation difference between LMFBR and the advanced converters, and because of the engineering decision that Clinch River is really a practical size as far as stepping forward from existing technology. I would like to know if you have any views on Clinch River? How would you go with the breeder demo? Specifically, how do you look at the concept based on your testimony on page 11 of what cooperative arrangements on the LMFBR with Great Britain and Japan are, that which Mr. Kratzer recommended?

Dr. LAMARSH. I think that would be an extremely fine idea to have a cooperative arrangement with any country.

With respect to Clinch River, let me say simply this. If I were designing and building a breeder of that size, I don't think I would have chosen that particular system. I would have gone to a pool type. That's one man's opinion.

As I am sure you are aware, there is a great difference across the world and in the United States as to the relative virtues of the loop and pool type of breeder.

Mr. McCORMACK. It is like having to choose between Ford and Chevrolet.

Dr. LAMARSH. I'd put it somewhat differently, but with almost the same analogy.

I visited both Phénix and SNR-300. SNR-300, the German system, is extraordinarily heavily built, as is Clinch River. I think the comparison between SNR-300 and Phénix is more like a Tiger Tank and a Citroen sedan. I had a talk with the superintendent of SNR-300. He said: "Don't tell anybody this, but I would never ever recommend building another one of these. They are just too heavy, too massive."

On the other hand, the French have an interest in SNR-2. Even though Phénix is a pool type system, they are hedging their bets. But the pool type, well, one look at Phénix and it just makes you a pool type fan almost immediately.

Mr. McCORMACK. I share your perspective. I visited Super Phénix last August. I walked around the vessel. It was nearly completed. It was in the middle of the construction operation. I was very impressed by the simplicity of the design.

Dr. LAMARSH. That is the wonderful thing about the pool type. They are simplistic. I think that we should still definitely go ahead with Clinch River. However, I would like to see the next large breeder in this country be the pool type.

Mr. McCORMACK. You don't see any disadvantage in going ahead with Clinch River and moving to the next machine?

Dr. LAMARSH. No. They are the same reactor type, Mr. Chairman.

Mr. McCORMACK. I want to thank you very much at this time for your delightful testimony.

Dr. LAMARSH. Thank you.

Mr. McCORMACK. It has been very helpful.

I want to say that, as you were giving your testimony, I was struck with the idea that one of the things the committee might do, and I am sure my staff will go in a state of shock when I tell you what I have in mind, but that we might abstract key statements from the testimony that we received yesterday and today in the hearings and assemble it for a statement in the Congressional Record, or an extension of remarks. That is so those persons that have not heard this testimony would have the benefit of reading some of the more graphic statements made. This is so that they can get a better understanding of the issues. If we go forward with that, we will include statements you made today.

Dr. LAMARSH. Yes.

Mr. MCCORMACK. We will do that with great pleasure.

Ladies and gentlemen, this concludes our hearings on this subject.

I want to say that this time that I have watched many of those of you here during the last 2 days. I am pleased with the fact that most of you stayed awake most of the time.

I want to thank you all for your participation. I think these hearings have been extremely beneficial. I think the Congress and the country will benefit from this attempt to try to explore what the policies of this Nation are, and what they should be with respect to our nuclear energy programs in the post-INFCE period.

I sincerely hope that the administration will see this also, and that they will see the advantages now of reviewing the previous postures and policies and moving into a more enlightened and more aggressive role of leadership and realistic support for these programs. This will be for the benefit of this country and the entire world.

I thank you all for coming. Thank you again, Dr. Lamarsh, for coming.

Dr. LAMARSH. Thank you.

[Letter from Dr. Lamarsh follows:]

LARCHMONT, N.Y., *June 6, 1980.*

Dr. STEPHEN LANES,
Staff Director, Committee on Science and Technology, Rayburn Building, U.S. House of Representatives, Washington, D.C.

DEAR DR. LANES: You will recall that at the end of yesterday's hearings there was a discussion regarding the production rates of plutonium in LWR's and in the LMFBR. I would like to clarify my remarks as follows.

In an LWR, the bulk of the power comes from fissions in ^{235}U. The conversion ratio is about 0.6, so a great deal of plutonium is produced and most of it is present in the fuel when this is discharged.

In an LMFBR, the conversion ratio is higher than in an LWR, between 1.2 and 1.4. However, the power is generated by plutonium and not by externally introduced fissile material as in an LWR. Thus, out of the 1.2 to 1.4 atoms of plutonium produced per plutonium atom consumed (the definition of conversion ratio), one of those atoms simply replaces the consumed atom, leaving relatively little in the way of excess plutonium produced by the reactor.

A nominal 1000 MWe LWR produces on the order of 200 kg of plutonium per year. With a conversion ratio of 1.2 an LMFBR yields about 100 kg per year. When LMFBR's get sufficiently developed to have much higher conversion ratios then they will produce about as much plutonium as an LWR. But until that time they will produce less. Also, note that at those times when there is an excess of plutonium, as there will be in the immediate future if we reprocess LWR fuel, then it is a simple matter to reduce the conversion ratio so that a breeder becomes a plutonium consumer.

It was a great pleasure to meet you and Congressman McCormack yesterday.

Sincerely yours,

JOHN R. LAMARSH.

Mr. MCCORMACK. We stand adjourned at this time. Thank you very much.

[Whereupon, at 5:05 p.m., the subcommittee adjourned, to reconvene at the call of the Chair.]

APPENDIX

EXXON NUCLEAR COMPANY, Inc.

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L. R. RAYMOND
[illegible]

June 26, 1980

The Honorable Mike McCormack
Chairman, Subcommittee on Energy
Research and Production
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. McCormack:

We are pleased to have the opportunity to submit a statement for the record of your timely hearings to review the outcome of the International Nuclear Fuel Cycle Evaluation (INFCE) and its implications for post-INFCE U.S. policy orientation and R&D activities.

If there were one conclusion that emerged as a consensus from the International Nuclear Fuel Cycle Evaluation, it was that non-proliferation policy is effectively linked to the reliability of fuel supply assurances. This factor is also central to the Nuclear Non-Proliferation Act of 1978. Unfortunately, the worldwide perception of the United States as a reliable supplier has slipped in recent years, as has its ability to influence international decisions in the nuclear energy area. Consequently, one issue which should be examined by your committee is the extent to which current policies should be reoriented to regain U.S. technology and fuel supply leadership and to enhance the U.S. image as a reliable supplier.

In this regard, there is one area, in particular, which we believe affords an outstanding opportunity to retrieve U.S. technological leadership and retain a substantial share of the international market. I refer to uranium enrichment, and more particularly to the highly promising laser enrichment technique. Whether or not we or others in private industry will be encouraged or permitted to participate in this sector, we believe it would be a serious mistake for the U.S. not to seize the opportunities currently available to it in the enrichment field generally, and the advanced isotope separation field specifically.

Reasons for Expanding U.S. Uranium Enrichment Capacity

There are a number of reasons which point to the need for a more aggressive program to expand U.S. enrichment capacity, based on more efficient and advanced technologies, consistent with U.S. objectives of maintaining a leadership role as a reliable supplier of nuclear fuel under effective safeguards.

- First, the U.S. is rapidly losing its position as a major supplier of enriched uranium to the Free World. As U.S. uranium enrichment policies have vacillated, DOE has been losing overseas customers because of their perception of the U.S. as an unreliable supplier of enrichment services. It is now estimated that the once paramount U.S. share of the total foreign (Free World) enrichment market will shrink to about 35-40% as early as 1985, and will continue its downward trend thereafter unless prompt corrective action is taken. The halting progress on the Portsmouth GCEP hardly seems likely to instill genuine confidence in our trading partners that the U.S. is seriously preparing to follow through on its global commitments to be a reliable fuel supplier. Anything short of an aggressive program to reestablish the U.S. as a reliable supplier of uranium enrichment services will be inimical to this nation's non-proliferation goals and may ultimately lead to technological dependence on other nations.

- Second, overly pessimistic demand estimates provide no room for an aggressive program to expand nuclear capacity in this country, an option which should remain open as a response to the continuing reliance on imported fuels for the generation of electricity. This option, in fact, has been endorsed by the joint communique released at the recent conference of heads of state in Venice.

- Third, we believe that the post-TMI assessments, notwithstanding the present lull in nuclear plant orders, support the expanded development of nuclear power to help meet the energy needs of the U.S. Our nation cannot afford to allow pessimistic predictions of reduced demand for uranium enrichment services brought about by the current debate to lead us into a misguided and unalterable reduction in our plans to increase enrichment capacity. Even if, contrary to expectation, it eventually develops that additional capacity is not needed as early as projected—or, indeed, even in the highly unlikely event that substantial additional capacity is not needed at all—the present energy-inefficient gaseous diffusion complex could gradually be retired and replaced by advanced technologies if, as expected, they prove to be more economically attractive and energy efficient.

- Fourth, it is essential that we press rapidly forward with development of advanced enrichment technologies. These more energy-efficient technologies cannot be considered commercially viable until production-scale plants are constructed and operated. Thus acceleration, to the extent practicable, of the demonstration of at least one of the existing technologies should become a DOE program goal. Once such plants are proven to be commercially feasible, availability of the new technology would allow more comprehensive planning for future enrichment needs. For example, it might be possible to replace, in whole or in part, the high energy consuming gaseous diffusion complex with more energy efficient technologies, thereby freeing up for other pressing needs a corresponding share of the 7,000 megawatts of electric power which will be required to operate the diffusion plants at full capacity. The more efficient new enrichment technologies would also further enhance the economic and conservatory benefits of nuclear power by improving the nuclear fuel cycle to yield greater energy benefits in return for energy investments, to the direct benefit of all electric power consumers. Further, implacement of these advanced enriching technologies could be the key to reestablishment of the United States as the dominant force in international nuclear fuel supply, with the attendant benefits of increased influence on non-proliferation matters and favorable impact on our balance of payments. It is widely believed the U.S. currently enjoys substantial leadership in advanced enrichment technologies, particularly in laser isotope separation. Failure to press forward aggressively will almost certainly forfeit this leadership position.

Pertinent NASAP Conclusions

The Department of Energy recently issued the final report of the Nonproliferation Alternative Systems Assessment Program (NASAP). We agree with the major findings and conclusions of the report as they relate to advanced isotope separation technology. They are consistent with the conclusions of the distinguished Laser Enrichment Review Panel convened earlier by Exxon Nuclear Company and the Avco Corporation to review the JNAI laser enrichment process. As you will recall from our statement during your Committee's September 22, 1979 hearings, the independent panel—composed of twelve distinguished scientists and foreign policy experts—unanimously concluded that domestic deployment of the JNAI process for the production of low-enriched uranium would be consistent with U.S. nonproliferation objectives.

Thus, we are now even more firmly convinced that laser enrichment development is not only consistent with the urgent national need to foster more efficient, economical and environmentally-improved technologies for energy production and conservation, but also fully consistent with U.S. nuclear nonproliferation policy and the principal findings of INFCE.

The Economic Potential of Laser Isotope Separation

The lifetime of the light water reactor industry depends upon the supply of uranium enriched in its U-235 isotope as fuel. The gaseous diffusion and centrifuge methods of enrichment can economically make available about 65% of the useful U-235. The remaining 35% is not available and is stored as valueless tails awaiting use as blending material for recycle fuels, principally for breeder reactors. Laser isotope separation (LIS) offers unique prospects of "stripping" these tails to recover over one-half of the remaining U-235 without impairing their utility as blending stock for breeder reactor fuel.

Although the economics of laser isotope separation have yet to be verified in a production demonstration plant, there are increasingly reliable indications that laser isotope separation technology will be capable of enrichment of uranium at costs substantially less than those of existing alternative technologies. In particular, the laser isotope separation process will require much less energy per unit of output, with energy requirements less than 10 percent of those of gaseous diffusion and comparable to those of the gas centrifuge. Furthermore, the laser enrichment technique is also expected to offer a significant capital cost advantage over both gaseous diffusion and gas centrifuge technology. Estimates indicate that laser isotope separation plant capital costs may be 10 to 20 percent of those of the gas centrifuge plants.

The current price of enrichment from the now largely amortized United States gaseous diffusion plants is approaching $100/kg of separative work, compared with a value of $26/kg only nine years ago. The major cause of this increase, and the principal contributor to the current unit cost, is the cost of electricity, which continues to escalate rapidly. While the energy component of gas centrifuge enrichment costs, like those of laser isotope separation itself, will be much smaller, the process is, nevertheless, highly capital intensive and these new investments must be amortized. Current indications are that the unit cost of separative work from gas centrifuge facilities may not differ substantially from the current cost of enrichment in fully amortized diffusion plants.

Under current economic conditions, enrichment costs account for roughly 25 percent of the total fuel cycle cost for a light water reactor. If laser isotope separation enrichment becomes available at a cost 50 percent lower than that of current technologies, a figure which falls within the range of informed estimates of its potential, cost savings for the United States' light water reactor nuclear capacity, as projected for the year 2000, would be about $1 billion per year.

Resource Conservation Benefits of "Tails Stripping"

Apart from its potentially large economic advantage in reducing the cost of the nuclear fuel cycle, laser isotope separation offers the prospect of recovering a substantially higher fraction of the U-235 from natural uranium than is currently economically feasible in either gaseous diffusion or gas centrifuge plants. The residue (or "tails") from these latter plants typically contains about a third of the U-235 originally in the natural uranium feedstock. The application of laser isotope separation technology to future enriched uranium production would effectively extend uranium resources by about 20 percent. Furthermore, similar processing of the existing stockpile of tails material accumulated at the United States enrichment plants over the last thirty years would provide the equivalent of around 70,000 tons of natural uranium feed, an amount corresponding to about four times the total United States production in 1978, with a value around $6 billion at current price levels. This economic benefit can be derived even if laser isotope separation is employed only to supplement other enrichment processes by tails stripping, without application to enrichment of natural uranium. Energy recovered from the tails stockpile attributable to laser isotope separation would be equivalent to some 3 billion barrels of oil.

Laser Isotope Separation Applications Options

The economic and resource conservation benefits of laser isotope separation can be realized from any of several different application options or from combinations of these options. Laser isotope separation can be used for further stripping of the accumulated tails stockpile and future tails from conventional gaseous diffusion or gas centrifuge facilities. This application enjoys a large economic return and could, in all likelihood, represent the first application of laser isotope separation technology. This application is also consistent with current Government planning that presumes the continued operation of the gaseous diffusion plants and the construction of new gas centrifuge enrichment capacity at Portsmouth, Ohio.

Another potential application option is to meet demands for additional capacity (beyond existing and planned facilities) through laser isotope separation. This option depends on the growth of demand beyond that represented by the nuclear generating capacity already in operation or under construction. If the economic potential of laser isotope separation technology is established through its application of tails stripping, it seems evident that the economics and technology of laser isotope separation for natural feed would also be established.

A further possibility would be the replacement of existing, less efficient capacity with natural feed laser isotope separation plants. By the year 2000, the gaseous diffusion plants will be about fifty years old. Even today, the price of separative work is approaching $100/kg and of this total, power costs account for some 50 percent. In recent years, DOE power costs have risen at an annual rate of about 20 percent. While future escalation rates are uncertain, it now seems quite likely that by the end of the century, and possibly well before, the power cost component of the gaseous diffusion plant operating cost may alone exceed the total (i.e., capital plus operating) unit cost of separative work from advanced enrichment facilities. In such circumstances, there will be powerful and growing economic and conservation incentives to minimize the use of gaseous diffusion capacity as rapidly as possible, not only to minimize costs but also to maximize the United States' competitiveness in the international enrichment market. Moreover, retirement of all or part of the gaseous diffusion complex would also release a corresponding fraction of the 7,000 MWe of power currently committed to these plants. The capital investment required to construct 7,000 MWe of new electric power generating capacity at current costs would approximate $7 billion.

* * * * *

In conclusion, we concur with the communique of the final plenary session of INFCE that "the findings of INFCE have strengthened the view that nuclear energy is expected to increase its role in meeting the world's energy needs and can and should be widely available to that end." We also support the INFCE conclusion that "A reliable source of supply of enrichment services can be an important factor in the achievement of non-proliferation objectives." It is in this vein that we submit our record statement in the hope that our comments may be helpful.

Sincerely yours,

for L. R. Raymond

best copy available